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Coast Erosion

PROGRAMS for conservation, in this country at least, have dealt principally with water for power purposes, and with timber and coal lands, so that in proposing the creation of a Federal Department of Foreshore Protection in the leading article of this issue Elmer L. Corthell calls attention to a subject the seriousness of which is not generally appreciated even by engineers. The waves are making a constant assault on our coasts and if this country would profit by the experiences of Holland, England, Belgium and other European countries it will need to adopt more vigorous measures than are displayed by the isolated and unscientific methods which now prevail. Mr. Corthell, in reviewing his forty-four years' experience in sea-defense works, makes the definite statement that any sandy coast can be permanently protected at reasonable cost, but it is useless to expect that vertical pile bulkheads with an unprotected shore in front of them will be effective in resisting the smashing blows of heavy storms. The Continental method of shore protection is by gentle slopes, covered with clay, straw and stone blocks. If properly built, spur groins, extending out beyond the main slopes, may be used to make the sea deposit its burden of sand, thereby building up the coast line instead of washing it away.

Careless Cement Advertising

SAND specifications are discussed editorially in this issue and also in the body of the paper—which affords a text to lecture cement companies, or, more properly, one cement company, for carelessness in writing its advertisements. One recent "ad" opens as follows: "How to Know Concrete.—Find out the quality of materials that go into its makeup. Clean, sharp sand, gravel and water are usually alike. The only other ingredient used—cement—is the thing that determines good concrete. Secure the right cement—high in tensile strength—and you are sure of securing right concrete work." The journal in which this advertisement appeared circulates among farmers. With them the most important thing, so long as the cement is a standard brand, is not high strength, but proper aggregate. Yet this advertisement would tempt them to slight the aggregate, for it says that sand and gravel are "usually alike." Even the recent graduate knows that this is not true. Nor does the qualification "clean" save the situation, for the use of bank-run gravel, always containing considerable sand, leads to lean mixtures and unsatisfactory construction. Cement sales ultimately are going to be benefited only by a better class of advertisement than this. Insistence should be placed not only upon freedom of the aggregate from loam and clay but upon screening, the separation from the larger stones of all particles under ¼ in., and then remixing in proper proportions. Considerable money has been spent by some companies in this type of advertisement. For steady and satisfactory growth all producers must fall into line in properly educating present and prospective consumers.

"Going Value" in the Public Eye

"GOING value" has come in for more than usual attention within the last few weeks. The New York Court of Appeals, the highest in the State, supported the lower court in allowing going value as an element in investment cost, while at Washington the Senate engaged in a protracted discussion over the confirmation of W. M. Daniels as a member of the Interstate Commerce Commission, the opposition being due to his known views in favor of going-value allowances. The airing of so important a subject in the public prints would have a beneficial influence were it not that the journals which, in the cities at least, seem to have the most influence are violently opposed to earnings on "intangible values," which to them are synonymous with the liquid in watered stocks. The heated atmosphere at Washington did not lend itself, either, to a fair presentation of the reason for allowing returns on development expenses. The terms "going value" and "intangible value" were tossed around glibly by the reporters, but nowhere, in this journal's reading, were these translated into actual expenditures in building up the property from the "dry bones" of a new physical plant into an operating entity. It behooves engineers whenever the opportunity presents itself to translate "going value" into the expenditures it represents. So long as it remains a vague, apparently theoretical term, so long will the average rate-payer feel that its inclusion in value is a victory for "high finance."

Preparing for Trade Expansion

While politicians are fighting over tolls exemption, making that issue overshadow all phases of the canal's future, the United States, according to John Barrett, director general of the Pan-American Union, is losing time, while other nations are actively preparing through port improvements and economic adjustment for the increased trade they confidently expect as a result of the opening of the canal. Said Mr. Barrett at the recent dinner of the Traffic Club in Pittsburgh: "The issue of canal tolls is absolutely unimportant and secondary as far as actual trade conditions are concerned when compared to the importance of practical steps to use the canal for the upbuilding of the export and import traffic of the United States. . . . There is not a great port, or exporting or importing center of Europe, Japan, Australia and of Northern and Western South America that is not doing more to get ready for the Panama Canal than our corresponding ports and centers of the United States, with the possible exception of New Orleans and San Francisco"—which is another way of saying that you can lead a horse to water but you cannot make him drink. The fundamental reason for this apathy is, of course, that the trade of the United States with the countries which will advantageously be reached through the canal is not as well developed as the trade between them and European nations. Furthermore, the American's instinct is to confine his business to the States. He knows conditions here; he has not, by a century of education through colonial enterprise, developed a commercial "wanderlust." American use of the canal will not be a mushroom but a slow growth, and will increase only as the attitude of the American manufacturer toward South American and Oriental trade changes. As that change comes it need not be feared that the adequate port facilities will not be developed.

Waves in Road Surfaces

IN advocating the use of three-axle road rollers to prevent or correct waves in bituminous surfaces Col. R. E. B. Crompton, of London, whose remarks before the Institution of Mechanical Engineers are abstracted in this issue, gives two reasons for the formation and development of waves. The first—that their origin is due to a percussive rather than a rolling action of fast-moving traffic—has already found recognition. His conviction that the bounding motion, especially when a large part of the traffic has similar characteristics, tends to create waves of uniform lengths, however, is not shared by American engineers. At recent highway meetings the influence of "harmonic motion" and the practicability of the three-axle roller have not received favorable consideration. Among the elements of construction advanced as having assisted in the colonel's deception are inferior materials and methods of application, insufficient rolling, and non-uniformity of the bituminous mixture. But these views, largely offhand, have little force in controverting testimony of an engineer who, during a long experience in designing and building highways, has made a careful study of the conditions which he discusses. He describes many measurements, and details at length his observations. His views on the three-axle roller have been just as painstakingly developed, and that he does not lack support was indicated in the article by Hamlet Cooper in the Engineering Record of Dec. 6, 1913, suggesting the same principles, and by the remarks of several English highway builders who have commented on the address. In view of the interest in the subject in England, American engineers might well make a more serious study of the possible effects of the "harmonic vibration" of traffic on the road surface. In any event, the suggestion of the three-axle roller deserves consideration because of the attention given it by men responsible for roads whose success is proverbial.

Discovering Efficient Men

THE Canadian Pacific Railroad has recently added to its staff a "scout," a man unknown except to a few officials, whose duty it will be to travel over the system and discover those employees who are especially worthy of advancement. Incidentally he will report those found wanting; but it is significant that his function primarily is not to make complaints but to make doubly sure that the deserving are recognized. Undoubtedly it is a step in the right direction. There is a feeling among railroad men that advancement is slow and that merit is not recognized. Very likely if men can be brought to realize that the display of initiative will be appreciated and rewarded their attitude toward their work will be decidedly changed.

An instance afforded by the recent blizzard in the East furnishes a striking illustration. A passenger train was stalled in a drift on the night of March 1 within 1½ miles of a freight-engine roundhouse and about 50 miles from New York. The following morning the conductor was urged to accept the proffered assistance of passengers in digging out the train, but he threw up his hands in despair, protesting that it was the worst storm in his thirty years of railroad experience and that the snow would drift back as quickly as removed. Moreover, he credited reports that in a cut ahead there were 6 ft. of snow. Passengers who in disgust walked to the engine terminal declared that the reports were untrue and reached New York long before the train was extricated. The line was open beyond the engine terminal. Had this conductor realized how much the road's officials would have appreciated his bringing in his train alone, while the officials were straining every nerve to open up the system, he might have displayed some energy instead of supinely submitting to discouraging conditions. If the scout idea will bring home to the employees of the Canadian Pacific that their interest in the road will be appreciated and rewarded, it will help much in raising the line's efficiency.

Decadence of Simple Sand Specifications

"SAND shall be clean, sharp and sufficiently coarse"—or "fine," as the case may be—such was the sand specification of the recent past. But engineers have been learning that more definite stipulations are needed if satisfactory sand is to be reliably obtained. For filtration purposes suitable specifications have been worked out by experiment and actual use. For mortar and concrete most users still essay to differentiate sands by looks and feeling. That other criteria were needed, especially for masonry of which strength, or watertightness, or both, were demanded has been realized by engineers who have investigated the subject.

Under the old specifications and methods of test dangerous sands have occasionally been used, unsuspectedly weak sands have frequently been accepted, while some excellent sands which did not look right have been rejected. In an endeavor to secure data for correcting this condition the engineering experiment station of the University of Illinois recently conducted an extensive investigation, the results of which have been published as Bulletin 70, "The Mortar-Making Qualities of Illinois Sands." Thirty-two samples of sands of widely varying character were subjected to sieve analyses and to tensile tests in mortar briquettes, while cleanness, voids, weight, specific gravity, mineralogical composition and sharpness were determined. Crushed-stone screenings were included in the study. Standard Ottawa sand was adopted as a basis of comparison, especially for the mortar tensile tests.

On the results of these investigations the author of the bulletin, C. C. Wiley, has based a classification and corresponding specifications for sands for concrete, mortar, plaster and paving grout. These specifications are reprinted on page 418 of this issue. Other valuable deductions were also made. "The mineralogical composition of a sand," it is stated, "is the fundamental factor in its mortar-making qualities, since not only its durability, but the size and gradation of the grains, the nature of the grain surfaces, the strength of the grains themselves, and all the other factors which affect the strength of the mortar, are more or less directly dependent on the nature of the component materials of the sand." Sharpness, in the sense of "angularity or irregularity of the sand grains, appears to exert no effect on the tensile strength of the mortar. In compression the sharp sands may show a slight advantage. Crystalline rocks when freshly fractured generally show surfaces of great smoothness to which cement does not adhere well; but when these grains have been worn down the surfaces become roughened and the cement adheres much more readily." Consequently the old-fashioned specification may not only be useless but harmful.

Cleanness, likewise, has been unintelligently interpreted. The Illinois tests show that "finely divided inert clay or loam may be present in an average sand to the extent of 10 to 15 per cent without appreciably affecting the strength of the mortar, provided the clay or loam does not adhere to the grains, while a very small quantity may seriously impair the strength if it forms a coating around the sand grains." This distinction of adhesion or non-adhesion to the sand grains of the dirt is a point which has been missed very commonly and may furnish the explanation for some unhappy experiences which have appeared to be almost mysterious. Wide variations were discovered in the times required by mortars made with different sands to attain their strength, the weak mortars requiring less time than the strong ones. Only five of the thirty natural sands gave a strength greater than the Ottawa standard sand; all of these were bank sands with rounded grains. A sample of limestone screenings, of exceptional quality, made the strongest mortar of all, but another sample of screenings gave only medium results. Generalizations as to the superiority of screenings, therefore, cannot be made.

That for almost all work involving strength, density or imperviousness of mortar the sand should be selected by tests is being made evident. Very simple tests will suffice in many cases. Investigations using compressive tests should be carried on extensively, at least to supplement and check the tensile tests, for most mortars and concretes do duty not in tension but in compression.

Federal Studies of Sewage-Treatment Methods

IN the past the U. S. Public Health Service has confined its activities very largely within medical limits, but of late the scope of its duties has been broadening. Among the first indications of its entrance into new fields were its stream-pollution studies, and now comes the announcement of an important program in the specialized field of sanitary engineering. This action was foreshadowed some months ago when Prof. Earle B. Phelps gave up his consulting practice in New York to enter the Government service at the hygienic laboratory in Washington. Since his appointment he has been formulating plans and organizing a staff for the study of certain phases of the sewage-treatment problem. Although it is still too early to discuss the plans in detail, it can be said that the investigations will cover two separate subdivisions of the general subject. The first subdivision—the design of works for the treatment of domestic sewage, with particular reference to plants for dwellings, hotels, institutions and very small communities—is in charge of Leslie C. Frank, a former member of the technical staff of Dr. Karl Imhoff. The second subdivision, which will deal entirely with the matter of trade wastes, is in charge of H. B. Hommon, who carried out the recent sewage-treatment studies at Akron and Cleveland.

Coming at a time when the pollution of the Great Lakes along the boundary line between the United States and Canada is under investigation by the International Joint Commission, whose expert, Dr. Allan J. McLaughlin, is also an officer of the Public Health Service, the action of the service is significant, for it is the latest manifestation of Federal interest in the subject of sewage treatment as distinguished from the sanitary survey of waterways. The earlier work has been largely in the nature of a diagnosis, although the U. S. Geological Survey has published several water-supply papers treating of sewage-disposal methods. The new studies deal with the cure.

A great deal of educational work will be required in this country before the problem of river pollution and sewage treatment can proceed along rational lines. This educational work is part of the program of the service. It is not proposed to usurp in any way the functions of consulting engineers, but rather to bring the smaller towns, with limited financial resources, to a realization of the sanitary problems which they must eventually face and to emphasize the importance of securing expert advice before embarking upon any project for the correction of nuisances. If the Public Health Service can be instrumental in creating a sentiment which will make for the rational design of treatment works and operation under competent supervision it will have performed a valuable service and have prevented the squandering of vast sums on ill-advised plans.

Valuation Report of American Society's Committee

SELDOM, indeed, has a paper read before the American Society of Civil Engineers or a report of one of its committees aroused so much discussion and adverse criticism as the report of the Special Committee to Formulate Principles and Methods for the Valuation of Railroad Property and Other Public Utilities. Nor has the discussion been confined to the members of the society. Public-utility men generally have been aroused, and the strength of the convictions can be gaged by the expression of an electric-lighting official: "If we cannot trust the American Society of Civil Engineers to think rightly on this subject, how can we expect proper views in Congress or among the people at large?" The report, which is entitled "Valuation for the Purpose of Rate-Making," was presented at the annual meeting of the society on Jan. 21, and, as a result of strenuous protest, was immediately referred back to the committee at its own request. Discussions of the report were then held on March 11 and April 2, the latter a five-hour session, and the document apparently is now in the committee's hands for revision, though a letter from Alfred Noble, read at the meeting of April 2, affirmed the committee's adherence to the equal-annual-payment method, and, therefore, to reproduction cost less depreciation as a basis for rate-making, around which the storm of argument chiefly centered.

That the committee departed from its designated purpose, as outlined in its title, is the first objection brought against the report. This is evident from the titles of report and committee. The committee chose to consider only one of the purposes of valuation. Had there been a further limitation—in the title merely—to waterworks properties, the storm might not have broken, even though the committee then would still further have failed to fulfil the purpose of its appointment. Waterworks men, generally, have found less to protest against in the report than the engineers of other utilities. A fallacy, not affirmed, it is true, in the report, but at least inferred, in the judgment of some, is that the value of the property may be the sole basis for determining rates, neglecting such factors as value of service and competition. One of the members of the society, therefore, suggested that the title of the report be changed so as to limit it to monopolistic utilities, of which waterworks are one of the most conspicuous.

Strongest protest probably was heard against the adoption by the committee of the depreciated value on which to figure return on the investment. While this view controverts the rulings of most State utilities commissions and the Interstate Commerce Commission, since they have ruled that depreciation is an operating and not a capital charge, it does accord with court decisions. These decisions undoubtedly influenced the committee in its stand; but there is, in addition, internal evidence that the waterworks members were chiefly responsible for the document. It reflects waterworks experience—an experience which forces one to adopt depreciated value rather than cost of reproduction new as the basis for the rate. In plain, unvarnished language, the waterworks owners have robbed their properties. They have taken out all they dared and left a decrepit outfit without any supporting depreciation fund. Truly, with them depreciation has been, as the committee defines it, "a payment from the ratepayer to the corporation of a part of its investment." No wonder, then, that courts have ruled that the depreciated value must be taken as the basis of the rate. The fallacy comes in applying this generally—to properties, too, which have been kept up and, from the operating standpoint, are in 100-per cent condition, even though physically they have dropped to an 85 or 90-per cent basis.

The difficulty in which the committee finds itself is due to its desire to stay within the Supreme Court's ruling—that return must be figured on depreciated value—and still not impair the value of the property, two things mutually self-contradictory. It is patent that if $100,000 be invested in a property, it should earn a fair rate of return on the full investment for its whole life and in addition, theoretically at least, sufficient to replace in the owner's hands at the end of the term his entire capital. In practice, of course, the utility does not come to an end at the close of a definite term.

Probably the best reason adduced in the discussion in support of reproduction cost new (without depreciation) as the basis for rate-making was that offered by Professor Swain. He pointed out that this reproduction cost new was to-day, in connection with old properties, the best substitute for original cost, which is, in general, not obtainable. For properties built hereafter, costs should be kept properly, so that the original cost may be known with certainty. Fortunately, the committee has agreed that actual cost is the proper basis, if known, and Professor Swain's point, therefore, carries all the more weight.

Reference has been constantly made in the discussion to the "length of life" of the property. The term is indeed pertinent when applied to a waterworks plant. The pumping station is a large part of the investment, and to renew it at the proper time a cumulative fund must be started long in advance. Applied to a railroad, with its myriad of component parts, the phrase loses its significance. After a few years of operation the railroad will require final renewals every year, and if well managed the amounts needed will be practically uniform. Hence no large depreciation fund will ever be necessary. A comparatively small amount will, as Professor Swain aptly put it in his discussion, serve as a reservoir, and will normally be accumulated in the early years of the property, before any considerable part requires renewal. Thereafter payments into and withdrawals from the fund will virtually balance, the reservoir taking care of fluctuations.

Looking from this angle, it is hard to see any point to the argument of some that allowance of profit on the undepreciated reproduction cost must be contingent on the actual setting aside of a depreciation fund. If the reservoir is empty it cannot take care of the fluctuations, yet a fair return will still produce in any year the average amount needed for renewals, and if this does not suffice the rest must be deducted from dividends. Therefore, if the directors have habitually been turning over to the stockholders money which should have gone to renewals the punishment will be automatic; the stockholders will have to do without dividends until the property is brought up to proper efficiency. If the road has actually failed to earn both reasonable dividends and the money required for renewals, then it has been denied a fair return and could not have met the demands of the sinking-fund, straight-line, equal-annual-payment or any other method of depreciation.

Finally, emphasis should be placed on a point made in the discussion of March 11, which the committee either did not consider or did not agree to. The committee held that the Supreme Court's ruling is final. True, it is in the specific case in question, but even the Supreme Court's views are subject by slow evolution to change, and there are not a few who believe that a better preparation and presentation of cases may eventually bring about rulings contrary to those in the Knoxville water and Minnesota rate cases. Certainly, there can be no hope for change if the Supreme Court's decisions are accepted without protest. Only by popular education, by repeatedly emphasizing right views on valuation, can the change be brought about. It behooves engineers, therefore, to preach widely their views of what is right, regardless of adverse court decisions, with the aim of having them accepted by utility commissions and eventually by the highest court.

As to the disposition of the report, it can safely be predicted that until radically modified it will not be formally received by the society.

The War Against the Waves

A Review of Forty-Four Years' Experience in the Protection of Sandy Shores from the Endless Attack of the Sea

By ELMER L. CORTHELL, Dr. Sc.
Consulting Engineer

BETWEEN land and sea an endless battle is being waged. Night and day the waves are continuing their assault upon the shores and for centuries past engineers have been struggling against the powerful invader. In the olden times their efforts were of little use, but years of defeat have taught their lesson and in Europe methods have been developed to resist the encroachments of the water. In the light of present-day knowledge any sandy coast can be permanently protected at a reasonable cost. Conditions existing in this country along the Atlantic and Pacific coasts require the adoption of a general policy and plan of shore protection in place of the isolated, unscientific and unsatisfactory methods which now prevail.

Recent disasters along the New Jersey and California coasts seem to demand a review of the writer's experience and investigations relating to the subject of coast erosion and the protection of foreshores. For the information of the younger generation of the readers of the Engineering Record the writer should say that for 44 years on many shores of many countries, both in the new world, north and south, and in the old world, he has studied these problems. It is impossible to deal with any riparian work, on river or coast, without being confronted with conditions which tax to the utmost the skill and patience of the engineer.

STUDIES IN EUROPE

IN 1897 the writer left this country for an extended tour of investigation in Europe. He was well equipped with a personal acquaintance with engineers whose works he intended to visit. He was also fortunate in securing the services of an engineering assistant, Bernard L. Green, who was well qualified to help him. The objects in view were universities and technical schools, on behalf of the University of Chicago, of which he was a member of the Board; subways in Budapest, Glasgow and London, with reference to the proposed subways in New York City; harbor and port works on the North Sea, the Baltic, and the coasts of Great Britain; rack railways, great bridges, water and sewerage works, and ship canals.

While in Paris, en route to Germany, Holland and Belgium, he was at the same pension with Frank Squier, Park Commissioner of Brooklyn. In the conversation about the writer's objects of investigation Mr. Squier suggested that as the foreshore conditions at Coney Island were giving a great deal of anxiety, for the shore was subject to serious changes, he advised that a part of the writer's time might be spent along the coasts of Holland and Belgium, in order to learn how these countries had protected their coasts under similar conditions.

The writer acted promptly upon this suggestion, and his extended examinations and investigations led him to the definite conclusion that any sandy coast could be protected permanently at a reasonable cost. The interest aroused by these examinations led to extended reading, study and correspondence with riparian engineers in many countries who had personal experience in such works. The writer's own works before and after this period confirmed the views formed by these investigations made in 1897 and 1898. It is a summary of these investigations that he proposes to give in this article.

The examinations covered the principal protected points of the whole coast of Belgium, Holland and Germany, on the North Sea, and the Baltic, Rostock, Lubeck, Stettin, Danzig, and the jetties at the mouths of their four rivers, Warne, Trave, Swine and Oder, since one of the objects of the writer was to ascertain how these works had been maintained against erosion or accretions or the wave action, with a view to learn how best to consolidate and maintain the Tampico jetties in Mexico, which had been built under his charge in 1891-92. During the investigations he visited points where the engineers informed him that it was the first time that any American engineer had ever been seen there. This is mentioned to show how extended and distant was the scope of the investigation.

Through the personal acquaintance which Capt. Eads and the writer had had from 1874 to 1891 with Holland's great engineer, Caland, who built the "Hook of Holland" waterway from Rotterdam to the sea, but who had died previous to the writer's visit there in 1897, he naturally looked for his son, who was stationed at Alkmaar, which in English means "all sea." And so it was when a small inclosing embankment, or levee, was started there in ancient times by a landowner on ground sticking above the tidal marsh. He built the embankment around his farm, and then other embankments around other farms followed until all the land to the sea beach was reclaimed. Then the fight against the sea began.

A knowledge of the formation and deformation of the North Sea coast of Holland is necessary for understanding what had to be done and why the engineers of the last 60 years have been the saviors of Holland, and why the old Dutchmen hesitated and finally withdrew from the eroding shore. He could fight to the last drop of blood against the Duke of Alva, Philip the Second's bloody despot, but the sea frightened him.

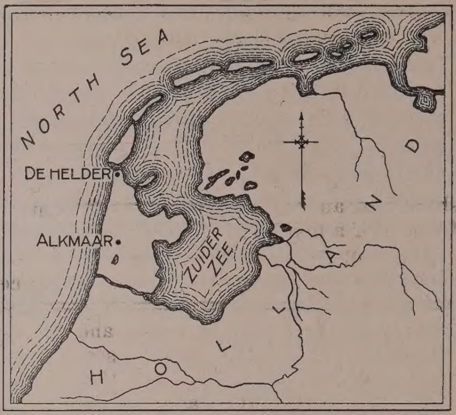


Fig. 1—Northwestern Portion of Holland

The whole Netherlands coast of the North Sea was protected by Nature by a continuous line of sand dunes placed there by the onshore winds which at low tide picked up the sand and deposited it along this cordon away from the high tide limits. About 600 years ago in successive storms, perhaps accompanied by tidal waves, the sea breached these natural dikes. At places far behind them the people built mounds (one of which the writer saw not far from the great artificial dike of Westkapelle on the Island of Walcherin), 40 or 50 ft. high, as a refuge for the inhabitants of the "polders" and their cattle and movables when at times the sea rushed through these great breaches half a mile to a mile wide in the chain of sand dunes.

In these breaches the engineers of these later times have built great dikes of clay and sand and have permanently protected their slopes down to below low water, and have by means of spur dikes, or groins, built of piles, willows and stones, forced the sea to recede—and stay receded. The map of the northwestern portion of Holland, Fig. 1, will show Alkmaar and Helder.

The writer was fortunate in obtaining, through the kindness of Mr. Lindo, city engineer of The Hague, a historical chart of the vicinity of Helder, a most interesting and conclusive proof of the encroach-

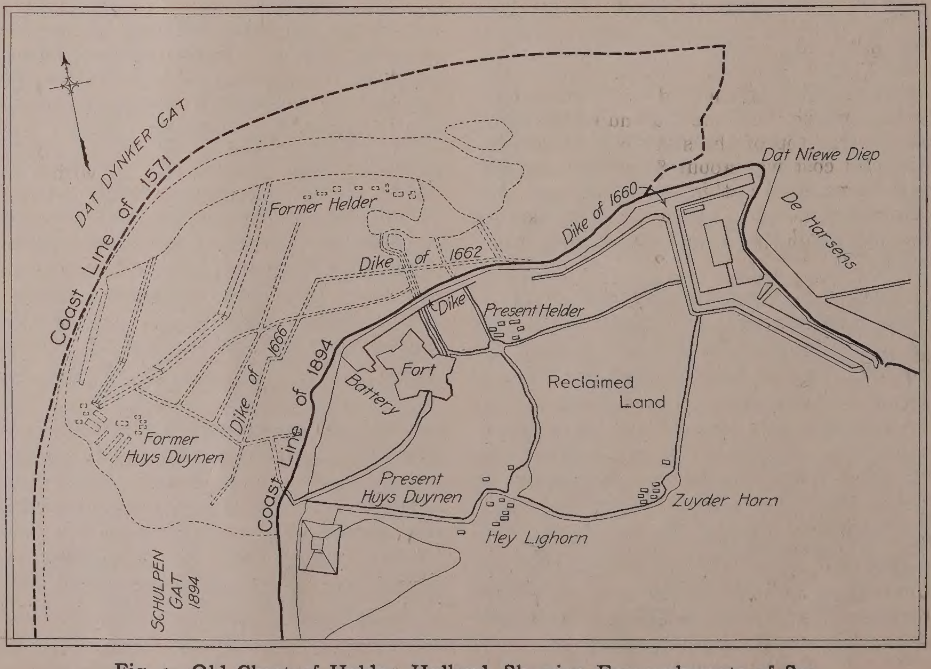


Fig. 2—Old Chart of Helder, Holland, Showing Encroachments of Sea

ments of the sea and of the holding of the coast against it by the engineer of modern times. This chart, Fig. 2, shows clearly where are now the former cities, buried beneath the sea. The outer line is the coast of 1571 and the inner line that of 1894. The ancient town of Huys Duynen was, in 1571, a mile or more out from the present shore line, and Helder, further north, three-fourths of a mile.

The map will show the changes in the shore line and the cadastral features since 1571, and the various broken lines of defence will show the half-hearted and unsuccessful efforts to drive back the sea. In the more southerly part of Holland the history of efforts and sea effects and final success to hold the shore are the same. A notable example is on the island of Walcherin not far from the city of Flushing, the terminal of one of the English Channel lines, where the dike of Westkapelle and its adjuncts hold back the sea and maintain the coast. It is within easy carriage ride of Flushing.

The writer cannot do better than to select the two works, Petten and Westkapelle as typical of the Holland method, and Belgian also, although there are many other shores on the North Sea protected in a similar manner. There are also several points along the sea boundary of both countries where municipalities are securely protected against shore destruction and their frontage held absolutely by marine slopes and walls for fine esplanades, like those at Ostend, Heyst and Bankenburg.

The principle on which the engineers of the last half century have based their plans and methods are simple and effective. The great destructive forces of Nature have been skilfully turned into constructive forces. They did not place an artificial wall, or "bulkhead," against the encroachments of the sea, but coaxed it to deposit its sands on the shore and so build it up, rather than throw them inland, and then, hungry for more, eat into the shore. The same lesson has been taught in Great Britain these modern times by Mr. Case and others, who appreciated the fact that its high chalk cliffs were no protection against the sea, and about which something will be said later on.

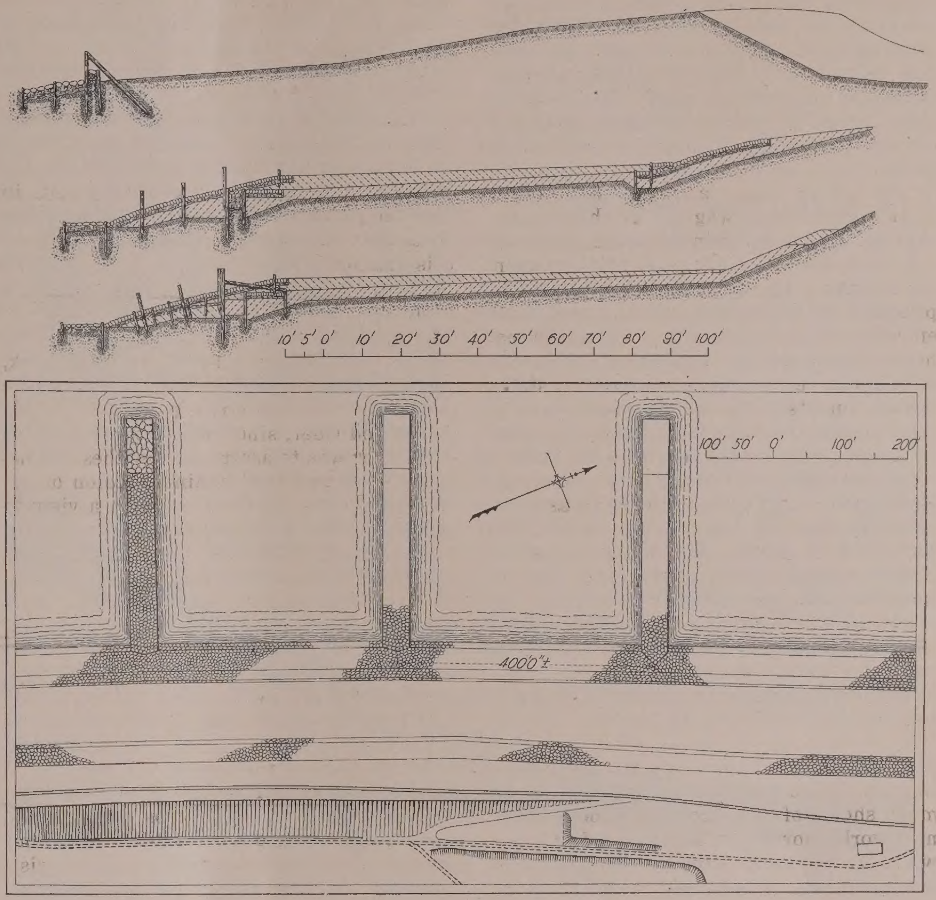


Fig. 3—Plan and Section of Petten Dike, Typical of Holland Methods

The clay slopes are covered with wheat straw and the protruding piles break force of waves; the spur jetties or groins in the plan are made of willow mats covered with basalt blocks and cause a deposition of sand.

HOLLAND METHODS

THE Petten dike, fully explained to the writer by Mr. Caland, is perhaps one of the best illustrations of Holland methods. The map and cross sections of this great dike, Fig. 3, over four miles long, show clearly the general method of construction. Its base width from the sea end of the spur dikes to the top of the slope is over 200 ft. The total cost was about $1,000,000, but it must be noted that this work not only protects the shore but is a substantial dike or levee four miles long and 20 ft. high, protected from low water to 23 ft. above high water, and has not only protected the foreshore slope but has rebuilt a destroyed shore. There are nearly 50 spur dikes, or jetties.

The land slope, not shown on the cross section, is generally 2 to 1, and it and the crown of the work, about 20 ft. wide, down to 16 ft. above mean high tide, is turf, except where paved with stone. The hatched area is a tough clay spread over the sand which forms the interior of the embankment. The entire slope up to 20 ft. above mean high water is liable to have a sea running up on it. The waves of a great storm in December, 1883, reached 19 ft. The rock work of the surface of the slope is entirely of basalt, generally used in Holland. It comes from Germany, on the Rhine. This rock is almost always hexagonal and usually the columns are from 8 to 11 in. in thickness. They are broken off about 18 in. in length and are columnar when in position on the slope. They are placed on a mat, or filling, of small osier willows, which are either made into fascines, or bundles about 5 in. in diameter and sometimes of great length, 40 to 60 ft., or packed in layers on the clay slope, all as shown on the sketch.

A row of stakes is driven firmly into the clay to separate the rock slope from the clay surface adjoining. The long flat clay slope between the rock covering and the sea slope is overlaid every autumn, after the threshing season, with wheat straw, which is laid in layers, like shingles, except that the butts are covered over, and the layers are fastened down to the clay by withes of straw laid parallel with the dike and pressed into the clay about six inches every six inches of length of the dike. This is done by means of a peculiar iron tool, or chisel, the end of which is hollowed out in circular form to catch the straw withe and jam it down into the clay. The covering of new straw presents a beautiful appearance and feels under the foot like a soft carpet. This "roofing" maintains itself under the storm wave action about a year, and it is then ripped off and a new covering of straw thatched down to the clay base.

The sea slope proper, going down towards high water level, is much more solidly built. The basalt rock is packed tightly and the stakes or small piles are much larger and stand up higher above the pavement. They are about 1 ft. apart, and of a diameter of 5 or 6 inches. The object of these piles is twofold—to assist in holding the stone in place (there are four rows standing above the rock slope and four flush with the surface), and to break the waves without stopping them and thus protect as much as possible the flatter straw slope above them.

The work extends from about 6½ ft. below mean tide level A. P. (Amsterdam Peil) or zero, to 20 ft. above it, or a total height of about 27 ft.; including the inside slope it is about 253 ft. wide. The entire seaside slope averages 1 in 8, but the matted slope is only about 1 in 40. The foreshore of pitched basalt next to the sea has a slope of about 1 in 4.

SPUR JETTIES

THE real effective effort against the encroachments of the sea is in the construction and maintenance of the fifty spur jetties or groins which appear on the plan. They are generally spaced about their length apart, or possibly a little more, or one and one-fourth times the length of the groins, and they are at right angles to the shore line. They are built of willow mats made of fascines and loose willows pinned and packed down solidly with a covering of basaltic rock about 18 in. thick. With a less thickness than this the waves would churn out and pull out the stones. Generally there are, lengthwise of the jetties, six or eight rows of small piles, not far apart, driven down until the tops are flush with the surface of the stone. The interstices between the stones very soon became packed with barnacles and shells, which materially assist in holding the stones in place. These jetties are generally about 350 ft. long and 40 ft. wide.

One of the first and desired effects of these jetties is a deposit of sand between them, extending from the shore to and even beyond the ends of the jetties, in many cases covering the side slopes and securely protecting them. The extreme ends are really the only exposed points and these need considerable maintenance work. This construction for maintenance consists of small piles driven in squares through the end of the work.

MAKING WINDS BUILD DIKES

THE reader will be interested in the construction of a dike made without hands, as it were. It was necessary to build a strong dike to connect with the sand dunes to the north of this work. The sand deposited between the jetties dries in the sunshine and blows ashore across the flats between the end of the embankment above described and the high sand dune. The blowing sand was caught by rows of tufts of dune sea grass, near at hand, spaced about a foot apart. The tufts in the rows were also spaced about a foot apart, simply little handfuls of grass. The whole surface of the dry sandy beach above high tide was covered with this plantation, and just back of it, at the highest point of the existing sandy area, one or two rows of reeds were set into the sand. Their tops were cut off and the stalks left standing about 4 ft. above the sand. The blowing sand, drifting over the surface, catches, and in one windy day will almost bury the tufts of grass and stand up a foot along the rows of reeds. Then another plantation was made, and another, until a massive dike or levee was built up 25 ft. high or more, to the height of the adjoining dike. In high storm tides the waves would eat into the toe of the slope and pull down the sand, but by the same process of building, the dike would be restored to its former size and finally permanently maintained. The cost of maintaining the whole work from one end to the other is not over $10,000 per annum.

This description, amounting practically to a specification, is from the writer's notebook, and was given by Mr. Caland while examining the work, although the examination of straw covering was made at Westkapelle and the shore protection there resulted from the same methods and was equally successful.

On the way to the Westkapelle dike to meet the engineers the road lies east of the serrated sand dunes bordering the North Sea, the low depressions between having been fortified with willow wicker fences to catch the drifting sand and build them up to the level of the higher ridges. On the right of the road is a vast alluvial plain, absolutely level, protected from the storm tides by this wall of sand dunes and the artificial dune at Westkapelle. Imagine our surprise at seeing on top of what seemed in the distance a huge haystack a browsing cow, appearing as we first saw her like the Lion of Waterloo, and on a very similar pinnacle. Getting nearer we saw it was an earth mound, 40 ft. high, and we learned that in some past century the sea broke through the chain of dunes and swept everything away in its mad rush—buildings, cattle, all movable things, and many of the people. After that calamity they went to work to build a refuge against any recurring breaks. Then in later years the great dike was built which absolutely protects the great area of rich country back of it.

It was at this dike that we came across a large gang of work men thatching the slope with wheat straw, as above described. The engineer had failed to meet us, and the foreman could speak nothing but Flemish. We were desirous to know all about the work. We could not understand the foreman and he could not understand our various languages, which one after another we tried on him. The situation was becoming critical. We noticed that he sent a messenger running towards a distant pile driver gang at work on a shore jetty, where by hand the piles were driven by means of a dozen men, each with a rope spliced into the running end of a larger rope reeved over a pulley. The twelve men with the twelve ropes all pulling together would raise the hammer and at a signal all would let it fall. We saw that on arrival of the messenger the work had stopped, and back he came on the run with a companion, who came rushing up to us and said in good American English, "What can I do for you, gentlemen?" "My glory," I said, "where do you come from?" "I'm a Dutchman, but I was seven years a foreman of a pile driver gang in Chicago." We could have wept for pure joy. It was he who gave us full information about thatching the slope and building the basalt protection which has been described when treating of the Petten dike.

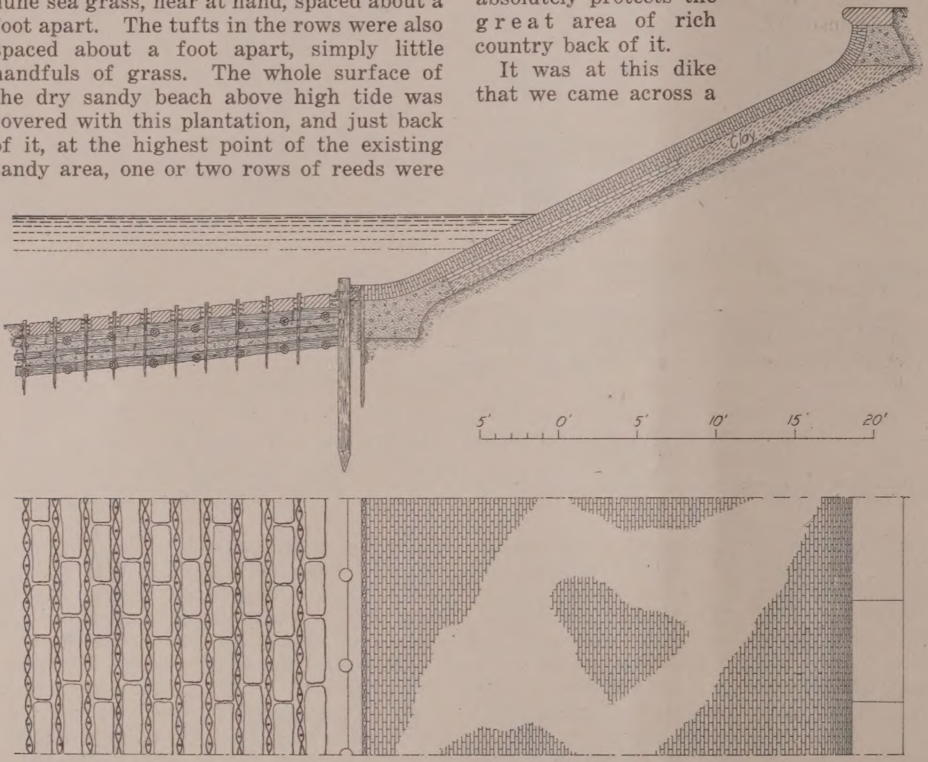


Fig. 4—Shore Protection Plan with Fascines Ballasted by Limestone Blocks

At Blankenburg, Heyst, Ostend, and at other points along the Holland and Belgian coast where watering places are established the foreshore is held in the same way as that opposite agricultural lands, but the protection above high water and the esplanade for a promenade is much more substantial and even ornate. In the plan and section, Fig. 4, note the granite coping, the concrete under it and, at the foot of the brick slope, the brick masonry of the upper slope, the fascine foundation under mean high water and the heavy ballasting with limestone blocks from Belgium.

The conditions, principles and methods proven effective by half a century of experience do not differ materially along the coast from Ostend in Belgium to the Dutch islands north of the mainland, two hundred miles of coast line. The movement of sand and water and the effect upon the shore and the construction require the highest skill, an intimate knowledge and long experience on the part of the riparian engineers of the country, who have proven themselves to be masters of the forces of nature.

There are points where the sea endeavors to obliterate the openings into the land, as at Calais, Dunkirk, Gravelines and Ostend, and sends its sands along the shore of the North Sea to furnish material for the Dutch engineers to rebuild the shores that the sea tries to wash away there.

To them belongs high honor, for in their territory the sea is everlastingly trying to encroach upon the land; the currents and the waves seem to conspire to destroy it, but here by the frailest of works and most perishable of materials, skilfully employed, the engineer is victor in the long, hard battle with the sea.

BRITISH COAST EROSION

THE writer has naturally not confined his attention to France, Belgium, Holland and Germany, the North Sea, the Baltic, but has, as opportunity offered in his examinations of harbors and coasts all around England, Scotland, Wales and Ireland, ascertained what the foreshore conditions are there, and how they have been treated. A battle there also is being waged between the sea and the land; the frontier line is pushed forward in one quarter and back in another. The tremendous and varying currents, the wind from many directions, the intermingling and opposition of great tides, the eddies and whirls, all present problems which contain as many unknown conditions as anywhere in the world. At many points the cliffs 30 to 60 ft. in height are formed of materials liable to slips and falls, which the sea quickly undermines and carries off. Along the Norfolk coast the wearing away of the cliffs and the foreshore is very rapid. At Cromer, Overstrand and Sidestrand there have been disastrous changes. At one point on this special stretch of coast there were 18 ft. of water in 1829, where half a century earlier there had been a cliff 50 ft. high, with houses upon it. Since then the conditions have so completely changed that there is nothing to indicate even approximately where the 1829 conditions existed. At one time in this vicinity ruined churches stood on the edge of the cliff ready to fall into the sea, no doubt gone by this time, churchyard and all.

Further to the east and not far distant the power of the all-devouring sea has been plainly shown. On the very shore, but rising out of the sand, splashed by the salt spray, rose a solitary tower, crowned by an octagonal lantern. This was all that was visible of the village and parish church. In 1892 a heavy storm wrote "finis" here and the waves worked their wicked will and beat down the tower.

The Story of Lost Lands

IN the County of Suffolk the saddest spot in the story of lost lands is at the little village of Dunwich, which is all that is left of a once flourishing city. This was once the seat of government of the king in the seventh century. Eleven prelates held their see in succession here, but even at the time of the Norman Conquest it was beginning to suffer from the attacks of the sea, although in the time of Henry II. it was a town "of good note abounding with much riches." Its fortifications were exceedingly strong and resisted the attacks of the enemy, the troops of King Henry's son. For King John it contributed several ships and in the reign of Edward I. maintained eleven ships of war. After 1328 the work of destruction went on at a lively pace. Soon a large part of the town, more than four hundred houses, was swept away. Then it went away piece by piece, now houses, now a church, now a monastery, now the jail. In the time of Queen Elizabeth four out of six churches had been "drowned in the sea." In her reign there were only 750 inhabitants. In 1891, when the writer was making some examinations of harbors and coasts, the number had shrunk to 213. The village remaining has now fled in absolute terror from the sea, and has straggled up a little valley inland. The sea ebbs and flows where once was the busy part of the populous town. All along the coast the same story is told. Dunwich is only a good illustration.

Engineers of earlier times, like the old Dutch engineers, were at a loss to know how to compete with the sea and stop its ravages. Walls, bulkheads, stone slopes, aprons, massive constructions, were soon swept away and the riotous sea still successfully ate into the solid land. No one had thought of simpler and more economical constructions, or that the sea could be made to build rather than destroy by building up a beach which would lie at the correct surface of repose.

Low Groins as a Solution

FINALLY came Edward Case, who invented and put into use extensively his very simple and inexpensive system of "low groynes" (see Fig. 5). They begin at mean sea level and extend in straight lines down to low water mark. There is no pile driving, no machinery necessary, no plant of any kind. A few planks 2½ x 3 in. and 7 ft. long, a little concrete to anchor them in the sandy or gravelly beach, a small gang of intelligent workmen with shovels, saws, some belts—that is all. These groins are of light construction, are invariably low in the first instance—not more than 18 to 30 in. being allowed to show above the beach level. Their object is to check the lateral and littoral currents and those of ebb and flood tide and induce the undercurrents to work up material toward the shore. When this has been effected fresh material is used, raising the groins, and the shore is gradually built up until the true shore curve, which is elliptical, is secured. When the sections are all correct and the shore filled in between the groins, the surface will be one of repose and will not alter.

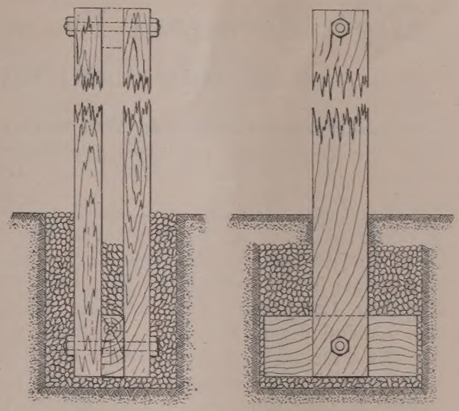


Fig. 5—Low Groins for English Coast

At many places in England and Ireland this system, built either by Mr. Case before his death, or since by his assistant, Mr. R. S. Allanson Winn, has been successful. The detail of the uprights and a map of England, Fig. 6, with the locations of the many defence works, are from London "Engineering," Jan. 27, 1899. A later article in the same journal by Mr. Winn, of July 24, 1903, will give further facts. At Eastbourne, on July 26, 1901, Mr. Winn read an important paper on the same subject before the Congress of the Royal Institute of Public Health.

Enough has been said in this article to disclose clearly the principles and methods successfully employed in several countries where conditions in general are like those in this country along our sandy and gravelly beaches and where the sea has generally proved to be an unconquerable enemy, using the weapons against it which are ordinarily employed.

The writer's extended investigations, his professional experiences and his observation and correspondence all lead him to the conclusion that principles and methods employed successfully elsewhere would be successful in this country if intelligently used—but not ignorantly. No invariable rule will apply. Differing conditions require differing treatments, and isolated efforts are not likely to succeed. It may be asked pertinently if our extended sandy coast line, generally sandy from Maine to the Rio Grande, many parts of our Pacific coast, and shores of great rivers, do not merit the care and attention of the Federal Government or at least the State governments.

The writer finds that an adaptation to United States conditions of the following specifications in the paper of Mr. Winn before the Eastbourne congress may well be offered as reasonable requirements upon the governments of those states whose borders are upon the sandy coasts of the ocean:

First, the constitution of a Department of Foreshore Protection, composed mainly of civil engineers expert in riparian engineering. Among the first and continued duties of this department should be:

(1) The systematic and repeated taking of sections (over the same lines) on all shores, as well as contours of high water, low water and mean sea levels, and also maximum and minimum waters, and particularly at mean sea level, as much damage is done during storms taking place at half tide.

(2) Systematic soundings over the areas of the underwater slopes out to 50 ft. depth below low water.

(3) Calculations based on observations respecting the varying rates and directions of currents at high water, low water and mean sea level.

(4) Observations as to the velocity and impact of waves.

(5) Observations as to the direction of the winds and direction of waves impinging upon the shore.

(6) Observations on the travel of beach gravel, sand and other material, especially

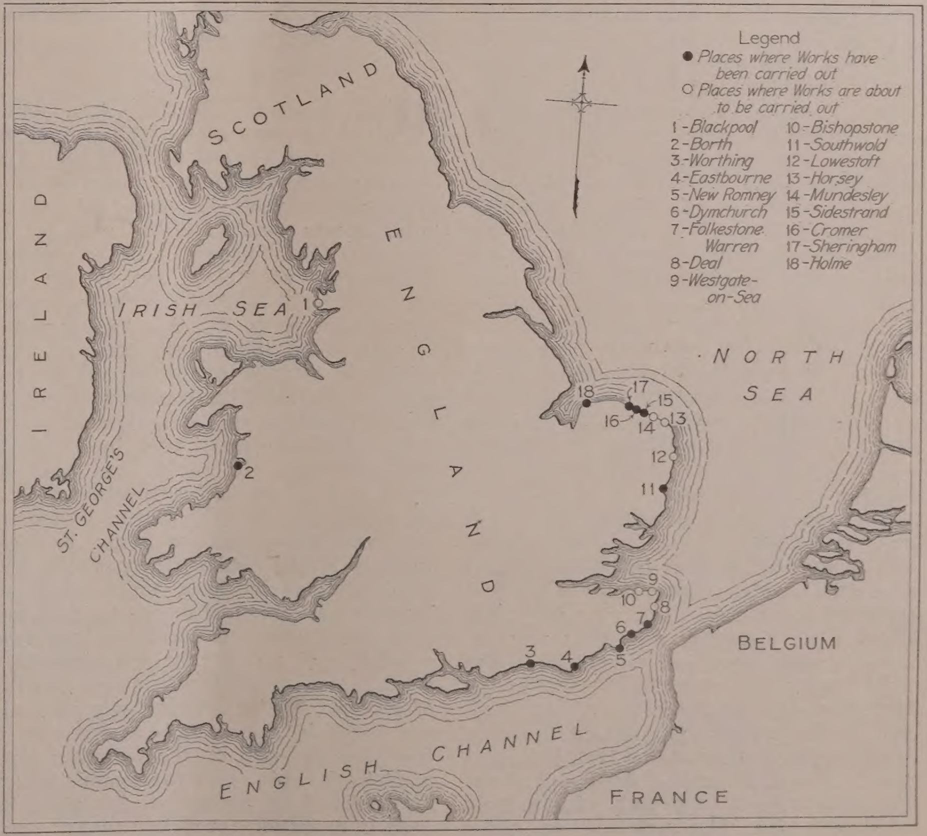


Fig. 6—Locations of Principal English Sea Coast Defense Works

around headlands, piers, breakwaters and other protruding obstructions and constructions, and across bays and estuaries.

CONSERVATION OF SHORES

WITH all the propositions and discussions of conservation by the National Government the conservation of the shores and their protection from the attacks of the sea would seem to have plenty of precedent for a national department of shore protection, and in that case the U. S. Coast and Geodetic Survey could well perform all the work outlined in the above suggestions, and no bureau of the Government is better qualified to collect the hydrographic and topographic data needed for wise, practical plans and constructive methods.

The writer is well aware of the objections that riparian owners will make to what they may call the flimsy constructions employed in Belgium, Holland and Great Britain. However, all will admit that the methods employed there have been effective in holding and building up permanently the foreshores. If there is combined with the protection of the beaches the solid portions of the slopes above high water, as in the plan for seaside resorts at Ostend, Heyst, Blankenburg, etc., there is no valid reason why Seabright, N. J., and other points along our coasts may not be permanently protected, but it is useless to expect that a vertical pile bulkhead with an unprotected foreshore in front in the sea is going to stand the stress and strain of heavy storms with their tremendous waves beating down all such frail protections and wrecking the property behind them.

Erecting Tall Steel Tanks from the Top Down

Novel Method Adopted of Assembling and Riveting the Upper Courses First

REVERSING the usual methods of operation, seven steel tanks 20 ft. in diameter and 50 ft. high were erected for the Procter & Gamble Soap Works, of Staten Island, N. Y., by the process of assembling and riveting the upper courses first. The tanks were built in courses 5 ft. high of steel plates from ½ to 5/16 in. thick, and had hopper bottoms. In order to avoid the construction of scaffolds and facilitate assembling and riveting, the erection was designed to be done entirely on the ground. Each tank passed through several floors of the finished building. Above the top of each tank four 12-in. I-beam floor joists formed a concentric rectangular panel, from which three 10-ton differential hoists were suspended, care being taken to hang them at points between the centers and ends of the beams so as to avoid maximum bending in the beams.

The upper course of plates for a tank was assembled on the ground and the tackles were attached to it through forged connections bolted to open holes in the field splice of the plates. The ring was then lifted 5 ft. high, the next ring was assembled underneath and riveted to it, the hoist connections were transferred to the bottom of this ring, the two rings lifted, and so on, successively hoisting the combined upper sections of the tank 5 ft. at a time. Five and one-half days sufficed for the completion of one tank with a force of sixteen men. The work was done under the direction of R. Dunseath, of New York.

High Tribunal Recognizes "Going Value" in Kings County Lighting Case

New York Court of Appeals Sustains Inclusion of Development Expenses in Evaluation for Rate-Making, and Makes Other Important Rulings

BRIEF announcement was made in the Current News of this journal of March 28 of the decision of the New York Court of Appeals in the case of the Kings County Lighting Company. The decision, which was handed down March 24, confirms the Appellate Division of the Supreme Court in its recognition of "going value," which the Public Service Commission had refused to recognize as a tangible factor in the determination of rates. It also confirms the Appellate Division in rejecting the commission's inclusion of annual appreciation of land as an item of income. With the commission's rejection of the company's claim for an allowance in the valuation for paving laid after the mains were laid, the Court of Appeals sustains the commission and reverses the lower court. The opinion, which was written by Judge Miller, is abstracted as follows:

It is now generally recognized that "going value," as distinct from "good will," is to be considered in valuing the property of a public-service corporation either for the purpose of condemnation or rate-making, but there is a wide divergence of view as to how it is to be considered. The commission in this case says it was taken into account in valuing the plant as a "going" and not as a "defunct or static" concern and that it was also considered in fixing the fair rate of return. The Appellate Division says that there is no proof of the latter fact in the record. Thus the first question certified requires us to decide whether "going value" is to be appraised as a distinct item, or whether it is sufficient to regard it as something vague and indefinable to be given some consideration but not enough to be estimated.

GOING VALUE

THE physical valuation was determined by ascertaining the cost of reproduction less accrued depreciation. Preliminary and development expenses prior to operation were included, but no allowance was made for the cost of developing the business. Hence "scrap" values were not taken, but to say that that sufficiently allows for "going value" is the same as to say that "going value" is not to be taken into account. The public is entitled to be served at reasonable rates and the company is entitled to a fair return on its investment on the value of the property used by it in the public service. It would have been entitled to a return on the valuation adopted by the commission if it had no customers, but was just ready to begin business, whereas it had a plant in operation with an established business, which every one knows takes time and money to build up.

If "going value" is capable of ascertainment it will not do for the commission vaguely to consider it in fixing the fair rate of return. That no appreciable allowance was made in this case is shown both by the rate fixed and by the following statement in the opinion of the commission:

"It should be noted that the plant has been in operation for nearly twenty years, and it might be argued with considerable force that two decades should be sufficient for the company to recoup its early deficiencies below a fair rate of return, if any such deficiencies ever existed. If the company has not recouped itself by this time, under such circumstances it is doubtful whether the present consumers ought to be burdened for this reason."

The first question certified then resolves itself into two heads: (1) Is "going value" a distinct item to be appraised and included in the base upon which the fair return is computed? (2) Was the evidence in this case sufficient to justify an allowance for it?

We concur fully in the opinion of Mr. Justice Clark that there is no "logical difference between allowing 'going value' in the valuation of a plant when it is to be taken entirely by the public and allowing the same element when valuing the same plant for rate-making purposes." It is no answer to say that in condemnation cases the exchange value is taken, and that that depends on the rates charged, the thing to be determined in rate cases. A rule of valuation might be adopted in a condemnation case which would not work in a rate case; but if the cost of reproduction-less-depreciation rule be adopted, it is impossible to see why the "going value" could not be determined in both classes of cases in precisely the same way.

DETERMINATION OF "GOING VALUE"

THE difficulty of determining the "going value" will not justify disregarding it. Rate-making is difficult, but that will not justify confiscation. The difficulty, however, will lessen, as it does in most cases, when we cease to think about the subject vaguely. What, then, is "going value," and how is it to be appraised?

It takes time to put a new enterprise of any magnitude on its feet after the construction work has been finished. Mistakes of construction have to be corrected. Substitutions have to be made. Economies have to be studied. Experiments have to be made, which sometimes turn out to be useless. An organization has to be perfected. Business has to be solicited and advertised for. None of those things is reflected in the value of the physical property unless exchange value be taken, which is not admissible in a rate case. The company starts out with the "bare bones" of the plant, to borrow Mr. Justice Lurton's phrase in the Omaha waterworks case (supra). By the expenditure of time, labor and money it co-ordinates those bones into an efficient working organism and acquires a paying business. The proper and reasonable cost of doing that, whether included in operating expenses or not, is as much a part of the investment of the company as the cost of the physical property.

The investors in a new enterprise have to be satisfied, as a rule, with meager or no returns while the business is being built up. In a business subject only to the natural laws of trade they expect to make up for the early lean years by large profits later. In a business classified among public callings the rate-making power must allow for the losses during the lean years, or their rate will be confiscatory and of course will drive investors from the field. In the former class, the value of the established business is a part of the "good will" and may be determined by taking a given number of years' purchase of the profits, or exchange value may be considered. In the latter case a different rule must be adopted.

If a deficiency in the fair return in the early years was due to losses or expenditures which were reasonably necessary and proper in developing efficiency and economy of operation and in establishing a business it should be made up by the returns in later years. If there was a fair return from the start, the corporation has received all it was entitled to, irrespective of how much of the earnings may have been diverted to building up the business.

Three Courses

To view the matter in another aspect, take the case of a public service corporation with a plant constructed just ready to serve the public. Three courses seem to be open with respect to rate making: (1) To charge rates from the start sufficient to make a fair return to the investor and pay the development expenses from earnings, a course likely to result in prohibitive rates except under rare and favorable circumstances; (2) to treat the development expenses as a loss to be recouped out of earnings but to be spread over a number of years—in other words, as a debt to be amortized—a plan that involves complications, but would seem to be fairer to the public and certainly more practical than the first; (3) to treat the development expenses, whether paid from earnings or not, as a part of the capital account for the purpose of fixing the charge to the public. The last course would seem to be fairest to both the public and the company, as well as the most practical. Treating a reasonably necessary and proper outlay in building up a business as an investment for the purpose of determining the fair rate of return to be charged is far from holding that it should be treated as capital against which securities might be issued.

The commission in this case had to determine the rate to be charged, not by a new company with no business, but by an old company with an established business. It was first necessary to determine whether the company had already received a fair return on its investment. If it had received such return from the start, or if in later years it had received more than a fair return, the public would already have borne the expense of establishing the business in whole or in part, and to that extent the question of "going value" for the purpose of fixing a present rate would be eliminated. If it did not receive a fair return in the early years owing to the establishment of the business, a subsequent rate must allow for that loss or it will be confiscatory. No dividends appear to have been paid by the original company or by the relator prior to 1907. Assuming a reasonable need of the service from the start, and that the failure to pay dividends was not due to bad management, an accumulation of a surplus or undivided profits, the investment of earnings in permanent additions or betterments allowed for in the structural valuation, or to other causes besides those under consideration, none of which is asserted, it would seem plain that "going value" was an element in this case which the commission was required to determine in making an appraisement on which to compute the fair return to which the company is entitled.

It is urged that an unprofitable business will thus have a greater value for rate-making purposes than one profitable from the start. That overlooks the fundamental consideration that a public-service corporation is entitled to a fair rate of return from the beginning of its investment and no more. If the shareholders have been deprived of a fair return on their investment because of the time and expense reasonably and properly required to build up the business, they have, to the extent of that deprivation, added to their original investment and are entitled to a return upon it. If, however, a fair return in addition to the expense of building up the business has been earned from the start, the public, not the shareholders, have paid the development expenses. No inflexible rule will in the long run be just both to the public and the corporation. The right to limit the corporation to a fair return fixed by public authority necessarily involves the correlative right in the corporation to be assured of that fair return during all the time that its capital is employed in the public service.

Good Management Assumed

Of course, a reasonable need for the service from the start and reasonably good management are assumed. While, within reasonable limits, service may be provided for anticipated needs, a company should not construct a plant in the wilderness and, after a city has been built around it, expect to recoup its losses while waiting, nor should it expect to recoup losses from bad management. I do not include in the latter mere mistakes or errors in judgment which are almost inevitable in the early stages in any business. I define "going value" for rate purposes as involved in this case to be the amount equal to the deficiency of net earnings below a fair return on the actual investment due solely to the time and expenditures reasonably necessary and proper to the development of the business and property to its present stage, and not comprised in the valuation of the physical property.

It remains to consider how "going value" is to be appraised. That presents a question of fact, the determination of which is primarily within the province of the rate-making body. It is proper for this court, however, to indicate a permissible method or methods.

Obviously, the most satisfactory method is to show the actual experience of the company, the original investment, its earnings from the start, the time actually required and expenses incurred in building up the business, all expenditures not reflected by the present condition of the physical property, the extent to which bad management or other causes prevented or depleted earning, and any other facts bearing on the question, keeping in mind that the ultimate fact to be determined is not the amount of the expenditures, but the deficiency in the fair return to the investors due to the causes under consideration. The business in this case was 20 years old, the books of the old company were not available, and it is of course problematical whether, if produced, they would have shown the necessary facts. The question, therefore, had to be determined by the best evidence available. The value of the physical property was shown by opinion evidence as to the cost of reproduction. The same kind of evidence was given by two witnesses for the relator as to the cost of building up the business to its present state. In the appellants' brief it is said that they were men "of mature age and much experience." There would appear to be as good ground for admitting the opinion of a qualified expert on such a subject as on the cost to reproduce the physical property. The commission had in addition the experience of the relator and its predecessors as to payment of dividends, the amount of capitalization of both, and the value of the physical property in its present condition determined as above stated. With nothing opposed to those facts and the opinion evidence it was not justified in ignoring the evidence of "going value" or of merely attaching some inappreciable importance to it.

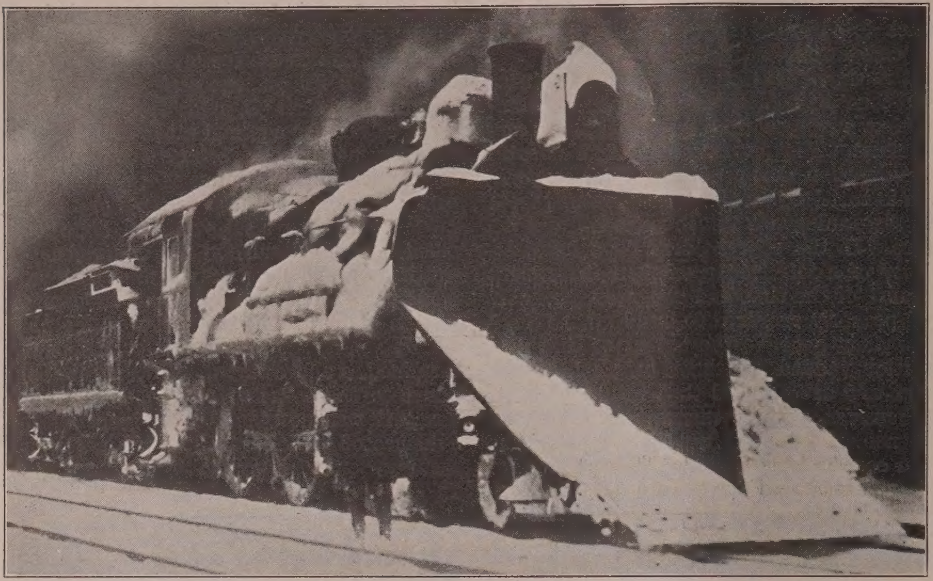
Pavements Subsequently Laid

In determining the cost of reproduction the commission allowed $12,717 as the cost of restoring the pavement as it existed when the mains and service pipes were laid in the streets. The relator claimed an allowance of at least $200,000 for the cost of restoring pavements subsequently laid on the theory that that cost would have to be incurred if the mains were to be laid to-day. But the new pavements in fact added nothing to the property of the relator. Its mains were as serviceable and intrinsically as valuable before as after the new pavements were laid. Should the public pay more for gas simply because improved pavements have been laid at public expense? The public are entitled to the benefit of the improved conditions, if thereby the relator is enabled to supply gas at a less rate. The relator is entitled to a fair return on its investment, not on improvements made at public expense.

It is said that the mains will have to be relaid. So will the new pavements, and much oftener. Both might possibly be relaid at the same time. The case is not at all parallel to the so-called unearned increment of land. That the company owns. It does not own the pavements, and the laying of them does not add to its investment or increase the cost to it of producing gas. The cost-of-reproduction-less-accrued-depreciation rule seems to be the one generally employed in rate cases. But it is merely a rule of convenience and must be applied with reason. On the one hand it should not be so applied as to deprive the corporation of a fair return at all times on the reasonable, proper and necessary investment made by it to serve the public, and on the other hand it should not be so applied as to give the corporation a return on improvements made at public expense which in no way increase the cost to it of performing that service.

We agree with the Appellate Division that annual increase in the value of land is not income. Of course, under the rule of the Ames case (supra), land might become so valuable as to require its use for other purposes and as to make a rate based on it unfair to the public. The present is not such a case.

COAL BRIQUETTES to the amount of 181,859 tons, valued at $1,007,327, were manufactured in 1913, according to Edward W. Parker, of the U. S. Geological Survey. Compared with 1912, there was a decrease of 17 per cent in tonnage but an increase of 5½ per cent in value.



Snow Plow After Twenty-five Hour Battle with the Drifts

How the Pennsylvania Fought the Blizzard

Story of the Tieup of the New York Division and the Way the Railroad Won the Struggle with Snow and Ice

ACTUAL damage done the Pennsylvania Railroad in the blizzard of March 1 and 2 amounted to more than $500,000. The total loss, direct and indirect, will run to $2,000,000. In the territory affected, which embraced practically all of New Jersey, the company has 1600 miles of track, over which 411 passenger and ninety-six freight trains run daily, carrying respectively 25,000 or more passengers and 4300 cars of freight. For twenty-four hours not a train left Philadelphia or New York. Nearly 7000 miles of telegraph and telephone lines parallel the tracks, and these were literally "shot to pieces. Not since the great blizzard of 1888 had traffic on the Pennsylvania Railroad been so completely paralyzed. The whole story of the storm and the way it was fought is graphically told in a pamphlet, from which these notes are taken, issued by the company's publicity department.

Storm Not Expected

THE storm came almost without warning. While there was one storm central over the Great Lakes and another over the Gulf States, the weather forecast for New Jersey was "fair and warmer." The prophets did not expect the two storms to meet as they did. Beginning early Sunday morning with a mixture of rain and snow, the temperature dropped below freezing, the wind increased and the snow fell faster, until by 4 p. m. the storm was a blizzard. At that time trains were still running, or at least moving. By 5 o'clock every overhead wire was laden with snow and sleet, and many were broken loose.

At first reports of wire trouble came thick and fast to headquarters of the New York division in Jersey City; then they suddenly stopped. All communication on the railroad's own wires between New York, Philadelphia and intermediate cities ceased by 6 o'clock. From all that could be learned the tracks were covered with fallen poles and tangled wires. By 7.30 orders had gone out to start no more trains from New York and Jersey City. It was midnight before the worst of the storm arrived on the west end of the New York division. Trains left Philadelphia for New York as late as midnight, and then everything stopped. And all the while the storm raged even with greater fury.

The division has a regular storm manual, a book of 36 pages, outlining the work every man is to do in case of a snowstorm. No orders are given; they are not needed. When it begins to snow every man goes to his place. Not only does this storm book outline the work for the division men, but it tells where extra laborers and snow shovelers can be secured, how many men can be obtained at various places, whether they have shovels and other tools, and how many are available at night. It also tells where snow plows and flangers are kept.

Railroad men know that when trains once get stalled in a heavy storm it is doubly hard to start them. The thing to do is to keep as many trains as possible on the road, but to make them light, with extra locomotives if possible, so that they can make speed and plow the snow from the tracks before it gets deep enough to halt trains.

How the Fight Was Handled

DURING the storm of March 1 and 2 there was no time to ask questions, and no way to ask them. The superintendent, engineer maintenance of way and division operator were on the job from early Sunday afternoon until late Monday, when the blockade was broken. They sent out trainload after trainload of men, and commissary trains and wreck trains. They kept in touch by roundabout long-distance telephone wires with Philadelphia, where others were working to free the division from the storm's grip. Men reported to them when they could. Every man that could be spared was sent out with gangs of laborers. Men out on the road had only one order, and that was "get the line open and keep it open."

It is impossible to tell what every man on the division was doing all of that raging Sunday night and Monday, but the experience of one assistant trainmaster was typical. He was off duty at Elizabeth when he heard that there was trouble on the road. Finding a freight train bound for Waverly, he jumped on the locomotive and ordered the engineer to uncouple from the train and start for Trenton to help trains in distress. Just west of Elizabeth they came across seven poles down over both westbound tracks. While the engine crew and the assistant trainmaster were trying to remove these poles others fell over the tracks behind them, making it impossible for them to move in either direction, and it took some hours to extricate their engine from the tangle. All of this time the blizzard was increasing in fury.

When it was evident that he could get no farther on this locomotive, he started out afoot for a light ahead, which he took to be the tower at Millstone Junction. It was about midnight when he started for the tower. After floundering around in drifts, falling time and again, he lost his way; the wind had turned him around many times. When he at length reached a light he found it was the locomotive of train 69, that had left Pennsylvania Station at 3.38 Sunday afternoon, bound for the South. It was then 1.10 a. m. Monday.

Early Monday Morning

BY 2 or 3 o'clock Monday morning the east end of the New York division was covered with work trains, wreck trains, and trains full of laborers from Jersey City. A snow plow was doing yeoman service, and laborers were shoveling snow and removing telegraph poles as they came upon them. In the cuts were drifts 4 and 5 ft. deep. Way stations were often distinguishable only by a chimney or gable sticking from what seemed to be a monstrous snow drift. Fences, trees, bridges and landscape had temporarily lost their identity in the all-impressive pall of white. It was literally pouring snow.

From Philadelphia they sent out a wreck train to hunt trouble, and at 7.30 p. m. they ordered a wreck train from Wilmington. It got to Philadelphia at 10.20 Sunday night. The men were fed and told to go ahead on the New York division. The first work this crew did was to dig its own train out of the snow before it had gone 50 ft. from Broad Street Station. It was 12 o'clock before they could get away from Philadelphia.

The office of the Maryland division at

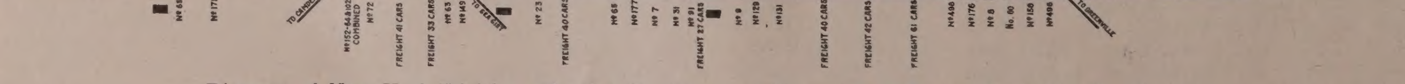


Diagram of New York Division, Showing Location and Character of Trains Stalled by the Storm

Wilmington was asked to send a trainload of men to the New York division as soon as possible. This train got away at 5.30 Monday morning. Harrisburg sent 300 men; Altoona 800. Other gangs came from Pittsburgh and Baltimore. Work trains from Renovo and Sunbury, with crews trained to fight blizzards, were rushed to the scene of trouble. These two gangs came with camp trains fitted with enough supplies to be out four days. From Philadelphia trainloads of snow shovelers were dispatched as fast as they could be obtained by contractors. By noon on Monday there were no less than 5000 extra men shoveling snow between Jersey City and Philadelphia.

FEEDING THE MULTITUDES

FEEDING for three days 5000 extra laborers and 2300 regular men, stretched out over 90 miles of railroad with no means of communication, proved a task the doing of which was another of the seemingly impossibles accomplished. The men were working against overwhelming odds, suffering greatly from cold, and could not make much headway without food. At Philadelphia the engineer of maintenance of way had charge of the commissary. The restaurant at Broad Street Station was kept open all Monday night, and more than 60,000 meals were sent out on special trains to feed the men as they found them along the road. The same thing was done at Jersey City. Commissary trains were sent out as fast as food could be prepared. The first train that left Broad Street Station, Philadelphia, Monday took 8000 meals; the next one carried food enough for 20,000 meals. Those in charge of these trains had orders to feed every man they came to and see that all had plenty of hot coffee.

Wires Broken Down with Ice

In addition to the commissary trains sent from Philadelphia and Jersey City, track supervisors at Tacony, Trenton, New Brunswick and Jersey City supplied laborers with food bought from nearby restaurants. Sandwiches and coffee comprised the menu of most of the 100,000 meals the railroad served its forces between Sunday and Thursday.

When Monday morning dawned, the Pennsylvania Railroad had nearly 2000 passengers marooned on eighteen trains stretched out between New York and Philadelphia. Fortunately, many of the marooned trains carried dining cars, where passengers could obtain food. All meals beyond those regularly served for a train on time were supplied free.

The station force used an extra engine and crew from 10.30 Monday morning until 1 p. m. to distribute food to the trains near New Brunswick. They had 3 miles of trains to cover, and they were making sure that no passenger should want for either coffee or eatables. They had all passengers fed in an hour.

By Monday night all the snowed-in trains had started on their way, most of them just twenty-five hours late. It was 8 o'clock before a regular train left either New York or Philadelphia. Tuesday morning trains were compelled to run slowly, as the dispatchers had great difficulty in getting orders to them. The dispatchers had been dropped by work trains at stations along the road to direct the movement of passenger trains in person, until wires could be repaired. Tuesday evening trains were leaving their terminals on time and arriving from an hour to two hours late. By Wednesday night they were on time and with practically no wires. Complete freight service was resumed Thursday.

Cracking of Drawn Brass

Discussion of Defects, Ascribed to Cold-Working, and Draft of a Proposed Specification to Govern Manufacture of Reliable Material

By ERNST JONSON
Engineer Inspector, New York Board of Water Supply

THREE grades of forgible brass are mainly used for structural purposes in this country—Muntz metal, naval brass and manganese bronze. Muntz metal is a mixture containing about 60 per cent. of copper and 40 per cent. of zinc. When this mixture is hardened by the addition of a small quantity of tin, generally less than 1 per cent, the metal is called naval brass, and when further hardened by a slight addition of iron it is called manganese bronze.

It is an old and familiar experience of workers in brass that a cold-worked metal may go to pieces either during manufacture or afterward if the piece is not annealed at suitable intervals during the work. It is especially in the cold-working of low copper alloys—alloys containing about 60 per cent of copper—that this trouble has been experienced. All such alloys when improperly cold-worked are very liable to so-called season cracking. It is natural that naval brass and manganese bronze should be even more susceptible to initial straining than the softer Muntz metal. Shipments of brass rods, especially of manganese bronze and naval brass, which had been carefully inspected and tested at the mill, have been rejected at the point of destination on account of cracks. Examination made of manganese-bronze studs for submarines being built at Seattle in 1912 revealed the fact that a number of these studs had cracks extending partly through them, thereby weakening them to such an extent that they might be twisted off with comparative ease. It is said to be a common experience in repair work to find brass studs twisted off which show old cracks extending some distance in from the surface.

In the new Catskill aqueduct, as pointed out by Alfred D. Flinn in his article, "The Cracking of Bronzes and Brasses," in the Engineering Record of Nov. 8, 1913, page 527, hundreds of bolts have been found cracked. Apparently exposure to the extreme natural range of temperature, as in passing through a winter, has caused these failures. In other cases the cracking has been directly traced to sudden cooling.

The main facts with regard to season cracking are as follows: After an extended search of the technical literature on this subject no evidence has been found that the chemical composition of brass or bronze has anything to do with season cracking, except in so far as it makes the alloy hard. A complete chemical analysis was made from drillings taken through the entire cross-section of a bar of manganese bronze which had developed season cracks. Analyses of the cracked portion and of the solid core show no essential difference between the two distinct areas in the metal. They also show freedom from any foreign elements which might have played a part in the peculiar behavior of the metal.

HARD AND SOFT ALLOYS

CRACKING is more likely to occur in a hard than in a soft alloy, particularly in high brass, and especially when hardened with tin and iron. Season cracking occurs only in brass or other copper alloy that has had some cold work done on it. The metal must have been cold-rolled, drawn, spun or treated by some other mechanical process in order to make it liable to such cracking. Some experiments made with 10 per cent aluminum bronze revealed the fact that plain hot-rolled bars did not suffer from season cracking, while the cold-drawn bars of the same material cracked after some time. About 2,000,000 lb. of manganese bronze castings have been made for the Catskill aqueduct, but no cracking has been observed in any of them. A large number of valve stems of forged manganese bronze have been used with satisfactory results. On the other hand, hundreds of studs have been found cracked, but not one short bolt with upset head, which had to be heated for the purpose of upsetting and was thereby annealed, was damaged.

Practically all of these defective studs had cracks in the unthreaded portion, but only a very few studs have broken in the thread. This indicates that machining off the surface, as is done in cutting threads, eliminates the danger of cracking. Long studs which for some reason have cracked on one side only have been found decidedly bent, with the cracks on the extrados. Test pieces cut from the interior uncracked portion of cracked studs give as good tests as those cut from uncracked bolts.

Cracked manganese bronze shows a considerably higher hardness under the scleroscope than uncracked material of the same kind. Lots of bolts which had developed cracks show hardness from 28 to 33 when tested with the diamond point, whereas those lots among which no cracked bolts were found show hardness below 28, often considerably below, going down to 19 when the material has been annealed. The elastic limit of cold-drawn bars is said to increase rapidly toward the surface.

The only theory which seems to fit these facts is that season cracking is a bursting due to initial stress augmented by temperature stress. When a bar is drawn through a die the compression is applied with greatest intensity at the surface, but, owing to the spreading of the stress, more gradually at points in the interior. The surface is, therefore, permanently deformed, while the interior is subjected largely to elastic compression. When the bar leaves the die the interior tends, therefore, to resume its original dimensions, but, being constrained by the permanently reduced shell, a part of the compressive stress remains and sets up a tensile stress in the surface layer. A sudden chilling of the surface of the bar would cause a tendency to contraction, which, when resisted by the interior, would result in a tensile temperature stress. These two stresses, when combined, might easily exceed the strength of the material and cause rupture.

This theory is in harmony with the facts that cracking is most likely to occur in the hard alloys, and that it occurs only when they have been cold-worked and not subsequently annealed or machined. It also corresponds with observations that the hardness is greater and the yield point higher at the surface than in the interior of the bolt. The idea of an internal compression balanced by a surface tension fully explains the case of a bolt bending when it cracked on one side only and thus relieving the tension on this side, and leaving that on the other to form a couple with the remaining internal compression. It also agrees with the observation that the part of the bolt which the crack has not yet reached is in normal condition.

The fact that in cutting a long thread on cold-drawn rods in a lathe it is necessary to make a preliminary narrow but deep cut, so that the change in length which results from the cutting of the outer layer of the rod may take place before the final cut is made, suggested the idea that a complete survey of the initial stresses in a rod might be made by measuring the variations in length resulting from cutting down the diameter of the rod. A piece of 1½-in. diameter cold-drawn manganese bronze rod 5¾ in. long was, therefore, cut off square at the ends and three measuring points, equidistant on the circumference, were established at each end. The original length of the rod was then measured and ⅛ in. was then turned off for a length of 4.15 in., leaving the original section of the rod undisturbed at each end. The length was then again measured. Another ⅛ in. was turned off and the length again measured. The measurements at each of the points, which were respectively marked 1, 2 and 3, were recorded separately, each one being the average of five independent measurements made by a 6-in. screw micrometer.

ELONGATION AND STRESS

WHEN the diameter of the center portion of the rod had been reduced to ⅜ in. the differences between the original measurements at each point and all succeeding ones were figured and the average of the three differences for each reduction of the diameter was taken as the true difference in length. From these differences in length the corresponding total stress in each of the removed layers was computed. The formulæ for this computation were developed as follows:

D_1, D_2 and D_3 were the diameters of the piece originally and after the first and second cuts; e_1 and e_2 were the respective elongations in inches; s_1 and s_2 were the respective strains per square inch between D_1 and D_2 and between D_2 and D_3.

$$s_1/e_1 = D_2^2/(D_1^2 - D_2^2); \quad s_1 = e_1 D_2^2/D_1^2 - D_2^2$$
$$s_2 = (e_2 - e_1)(D_3^2/D_3^2 - D_4^2) - e_1; \quad s_3 = (e_3 - e_2)(D_4^2/D_3^2 - D_4^2) - e_2$$

The corresponding stresses cannot be less than $P = E_s$. In the present case $E =$ 14,000,000 lb. per square inch.

The following table gives the results:

Diameter, inches	Difference	Lb. per sq. in., unit stress
1½	......	21,300
1⅜	0.0012	10,600
1¼	0.0021	20,300
1⅛	0.0040	11,800
1	0.0060	3,900
⅞	0.0075	17,400
¾	0.0085	23,300
⅝	0.0092	31,000
½	0.0092	31,000
⅜	0.0092	31,000

The unit stresses refer to the 16-in. layer inside the given diameter, except the last figure, which is the unit stress in the remaining ⅜-in. diameter core.

It was later found that this method of measuring initial stress in rods was described in Martens-Heyn's "Materialienkunde." In this book was also found a test for the tendency to season cracking. This test consists in immersing a piece of the rod in a solution of mercury salt. A number of tests have been made by immersing pieces of rod about 6 in. long in a saturated solution of mercurous nitrate. In one case after two hours' immersion the specimens were found to have developed a large number of transverse cracks spaced about ½ in. apart and about ⅛ in. deep.

PROPOSED SPECIFICATIONS

THE question naturally arises whether manganese bronze and naval brass, and perhaps all high brass, should be unconditionally condemned as unfit for structural purposes, or whether these alloys may be safely used when certain precautions are taken. The structural uses to which the high brasses are now being put involve duties too important to justify the engineer in taking chances with cold-worked material. And there is no occasion for doing so because hot-worked manganese bronze rods and bars are now being both extruded and hot rolled, giving 70,000 lb. ultimate strength and 40 per cent elongation in 2 in. Naval brass produced by the same methods give 60,000 lb. ultimate strength and 40 per cent elongation in 2 in. Such materials as these ought to answer most purposes, and there does not seem to be any real need for cold-drawing.

Whenever it is impracticable entirely to eliminate cold-working, as is the case in the manufacture of tubing, and when drawing is desirable on account of the exact size and finish which it gives, the initial stresses set up by the cold-working should be eliminated by sufficient annealing. When great stiffness is desired—that is, high elastic limit at the surface—cold-drawn bars must be used without annealing; but such material must be prepared with great care so as to eliminate the initial stress due to the drawing. This may be done by cold-rolling, the axes of the rolls being set at a slight incline to that of the rod. Such rolling will enlarge the outer layer of the rod and thus relieve the tension in it.

The following specifications for rolled, extruded and drawn structural brass are proposed:

COMPOSITION BY PERCENTAGE

	Copper	Tin	Iron	Lead	Zinc
Muntz metal..	59-62	....	......	0.6 max.	Rem.
Naval brass..	59-62	0.5-1.25	......	0.2 max.	Rem.
Manganese bronze	57-61	0.5-1.25	0.5-2.0	0.2 max.	Rem.

MINIMUM PHYSICAL REQUIREMENTS FOR HOT ROLLED, EXTRUDED AND ANNEALED MATERIAL, IN POUNDS PER SQUARE INCH

	Yield point	Ultimate strength	Elongation, per cent
Muntz metal......	20,000	50,000	32
Naval brass	22,000	56,000	32
Manganese bronze	27,000	68,000	32

DRAWN MATERIAL NOT ANNEALED

	Yield point	Ultimate strength	Elongation, per cent
Muntz metal......	25,000	50,000	25
Naval brass.......	30,000	60,000	25
Manganese bronze	35,000	70,000	25

For sheets and tubing the required minimum elongation shall be 5 per cent less than given in the table. All material shall stand being bent cold through an angle of 120 deg. and to a radius equal to its diameter or thickness. Bars shall stand being hammered hot to a fine point. Scrap shall not be used in the manufacture except such as comes from the same composition made in the same mill. The material shall be free from all injurious defects, and shall be clean, smooth and straight and of uniform quality and size. Unless otherwise specially permitted, all bars shall be extruded or hot-rolled and not subsequently drawn or cold-rolled. The straightening of hot-worked material shall be done by simple bending, not accompanied by compression between two opposite rolls. Plates shall be hot-rolled, except that sheets less than ¼ in. may be cold-rolled and annealed. All hot-rolled material shall be tested with the scleroscope and if the hardness is found to exceed materially that typical of hot-worked metal the rods shall be annealed.

Drawn and unannealed material shall be tested for initial strain. In case of material ¼ in. or more in thickness this test shall be made by measurement. When so tested the maximum strain shall not exceed 0.002 in. in a length of 4 in. The test specimen shall be 5¾ in. long.

After the length has been measured the test specimen shall be cut down for a length of 4 in., as follows: Bars shall be turned to one-third of the original diameter. Flats shall be machined to one-third the original width and thickness and plates and tubing to one-third the original thickness. The length shall then again be measured. The difference between the two measurements shall be regarded as the maximum initial strain.

Bars shall be measured at three marked equidistant points on the circumference; flats and plates at two points, one at each edge. Test pieces of plates shall be 2 in. in width. Each measurement shall be the average of five observations at each measuring point. In testing tubing the entire section shall be used, one-third of the thickness being turned off on the outside and one-third bored out on the inside. Sheets and tubing less than ¼ in. in thickness shall be tested by immersion in a saturated solution of mercuric chloride for one hour, and then kept under observation for two weeks. If cracks appear during this test the initial strain shall be regarded as excessive. When doubt exists the specimen shall be slightly bent to open cracks. Test pieces subjected to this test shall be 5¾ in. long and 2 in. wide.

Training for Public Service

Discussion on Co-operative Plan for Proposed National University, Prepared for House Committee on Education by Herman Schneider, Dean of the College of Engineering, University of Cincinnati

THE proposal that the Government establish a national university at Washington presupposes that the Government has a definite educational problem to solve and that no existing agencies do or can solve it. Juxtaposed statements of the many problems facing the Nation which can be met by education, and of the facilities offered by the established institutions of higher learning, disclose at least one major problem unsolved or unsolvable without the organization of a new institution—namely, the training of experts to do the work distinctly peculiar to Government. Such work, for example, includes service in the diplomatic and consular fields, in the Patent Office, in the Bureau of Printing and Engraving, in the Agricultural Department, in the Industrial Relations Commission, in the Interstate Commerce Commission, and in many other departments and commissions.

It is evident without argument that the high degree of efficiency required to meet the growing complexity of governmental activities can best be obtained by selecting persons of reasonably demonstrated fitness for the service, training them in the actual work and supplementing their training with an equal amount of co-ordinated instruction and research.

This task of selection, followed by prearranged and co-ordinated work in practice and theory, would seem impracticable but for the results accomplished under more difficult conditions in the engineering college of the University of Cincinnati. The co-operative system of this institution provides a means whereby engineering students work alternate bi-weekly periods in practical engineering work and at the university. The 400 students taking the co-operative course are divided into two sections, which alternate with each other, so that both shop and school are always full-manned.

The course is five years in length and operates eleven months a year. The practical field work is as carefully arranged for its training values as is the university curriculum; the students are paid for their field work at the same rate as any regular employee doing the same class of work. Sixty manufacturing, transportation, public-service, and consulting concerns are in co-operation with the university.

The particularly significant fact established in the eight years of this work is that the plan is entirely feasible and desirable, not only in foundries and machine shops and on railroads and outdoor construction, but also in research laboratories, designing departments, and public-service positions of real responsibility.

Here, then, is a going solution of a problem similar to that confronting the Government. It is being operated under more difficult conditions, for it co-operates with sixty concerns under separate and distinct managements, while the Government owns and operates all of its departments and bureaus. The Cincinnati system must meet successfully (and has met successfully) problems incident to daily commercial production—harmony with employer and employee, business depressions, small margin of profit—which do not obtain in Government work. In fact, no more rigorous test of such a system could be made than under modern industrial conditions. It cannot be held, then, that the plan is not feasible. Its desirability seems too obvious for argument.

The application of the co-operative plan to a national university having as one of its functions the training of Government experts can be considered most succinctly under the three basic principles of the system—selection, practical training, and coordinated instruction.

SELECTION

AT the University of Cincinnati the applicant is required to present a high-school scholarship record which presumably indicates his mental ability. He is then required to serve three months of full-time work under observation in the field of engineering he has chosen. If he gives evidence of fitness, he is admitted to the university. The real weeding out of the inapt and the relocation of the able but misplaced go on through the five years of combined work in theory and practice.

The national university, however, will be a post-graduate school, and hence its selective system will be simpler and surer; for during his undergraduate career a young man has demonstrated his positive tendencies. Thus in biology he has shown marked ability and has taken his majors in this science. He has a knowledge of the subject sufficient to enable him to enter certain scientific bureaus of the Department of Agriculture, and it has been shown that he has a strong bent toward biological work of this character. Upon graduation from his undergraduate school, and presenting proofs of his special ability, he would be admitted to the bureau and to the national university. In other words, the candidate would be accepted upon the recommendation of the undergraduate faculty that he was adapted to and prepared for his national university co-operative course. If an undergraduate faculty fell below a certain percentum of successful recommendations in course of time, candidates presented by that faculty could be required to undergo a rigorous examination by the national university until such time as the percentum of successes stood above the established minimum. Since the system would apply to all or nearly all of the Government departments, the national university, together with the department and bureau chiefs, could specify the major studies in which an applicant must be proficient in order to enter any particular department. Thus, upon investigation it might be found that the applicant for training in the consular service should present majors in history, political science, economics and international law; in the geodetic survey, courses in civil engineering, with special work in astronomy. In short, the requirements for admission would be, first, the successful completion of an undergraduate course, containing such major studies as might be required to begin work in a specified department; and, second, reasonably demonstrated ability for the work selected.

The organization of the practical work would be effected by conferences between the heads of the co-operating departments and the national university professors. Thus the question to be met in the training of men for the consular service would be, What departmental experience should a well-trained consul have? Analysis and synthesis would lead to a plan of carefully selected progressive experience in appropriate bureaus of several departments—State and commerce, for example. It is not improbable, too, that further experience in a banking concern doing a diversified foreign business would be found advantageous. The occasional use of privately owned training facilities could be arranged without difficulty. The essential factor in the training part of the scheme is the planning of the practical work to meet comprehensively the demands of the positions for which the graduate students are being trained.

After the logical advancement of the student from the simpler to the more complex forms of work has been agreed upon, the details of actual operation will not be found very vexing, if the more exacting form of co-operation at the University of Cincinnati may be accepted as a criterion. Accepting this criterion further to establish a basis of payment to the graduate students for their work, it may be assumed that their minimum salaries would be the same as those of other Government employees doing the same kind of work; their greater efficiency, resulting from special fitness and the co-ordinated instruction, would more than equalize any loss due to part-time employment. A diversified training is necessary not only to insure against the unbalanced judgment which is the result of premature and restricted specialization, but also to ascertain in which bureau a student's peculiar abilities render him most efficient. The periods of alternation of school work and field work would vary in different departments; thus in the geological survey the alternation might be by three-month periods and in the Congressional Library by half-day periods, which would probably be the extremes.

INSTRUCTION AND CO-ORDINATION

THE university work should be of a post-graduate character—that is, individual conference, seminar and research work in appropriate majors and minors. Some of the more general courses would not parallel the practical work, but certain specific courses would. The research problems would be suggested largely by basic questions arising in connection with the training plan; in fact, the purest type of research would be stimulated. The conference and seminar work would be partly in the nature of co-ordination, and, in addition, there would be special co-ordination mechanism. For example, when a student finished the work of one bureau and began in another he would be given a "syllabus" for the new bureau, including, first, directive information concerning his new task, to accelerate his rate of increase in efficiency; second, especially important matters to be observed in connection with the operation of the bureau; and third, a series of questions relating to the organization, operation, articulations and detail processes of the bureau, to be answered within a given time by personal analysis.

Successful completion of the co-operative training should insure entrance into the service, at a grade to be determined, just as graduation from West Point guarantees admission into the army with a certain standing. Indeed there seems to be no rational reason why training for important posts in the civil service should not be as much a function of Government as training for like posts in the military service. The present method of selection by examination is admittedly an expediential compromise. Unquestionably the additional cost of the university to the Nation would be more than met by the increased efficiency of the Nation's servants. Nor need the cost be great, for under the co-operative system the university uses existing facilities, and hence its expense is confined to teachers, classrooms and special laboratories. In fact, the co-operative system is merely a combination of the old-fashioned thorough apprenticeship and the old-fashioned "college," with the obviously necessary co-ordination.

The old-fashioned apprenticeship possessed real educational values, but because of specialization it has been gradually disappearing instead of extending to more and higher phases of human activity. Fortunately we are beginning to realize that our carefully designed mechanisms for production, construction and distribution are in the truest sense laboratories, whose educational worth it were folly longer to ignore. More significant still, because of the rapidly growing complexity of governmental functions, are the educational opportunities at Washington; their utilization through co-operation would enhance manyfold the value of the national university.

The specific work outlined in the foregoing is not exclusive; it could not possibly interfere with any other work which might properly be done by the proposed institution.

Specifications for Sand

Based on Tests Made at the Engineering Experiment Station of the University of Illinois

PUBLICITY given in recent years to tests of natural concrete aggregates is gradually bringing constructors to a realization that careful specifications for the sand, gravel and broken stone are quite as necessary as standard specifications for cement. Even now, however, much sand is still bought under the specification that it must be "clean and sharp." In view of this condition, a series of tests to determine the mortar-making qualities of a number of representative sands in common use in the cities of Illinois was undertaken by C. C. Wiley, of the Engineering Experiment Station of the University of Illinois, with the belief that such data would be of assistance to the engineers and builders of the State in making an intelligent and economical use of the available sands. The results have been published in a bulletin entitled "Mortar-Making Qualities of Illinois Sands." In the concluding pages the following proposed specifications for sand are found:

Prefatory Observations

IT is generally acknowledged that the specifications most frequently used for sand are inadequate in that they are too brief or too indefinite to secure the desired results. Recent specifications have overcome these defects in some respects, but most of them are objectionable in that they are too inflexible, i. e., fail to allow variations in the quality of the sand to meet varying conditions or different requirements, or else by placing undue stress on some particular requirement bar from use sands which would prove entirely satisfactory. The following specifications have been prepared with the idea of giving this necessary flexibility and at the same time making them sufficiently rigid. It is not intended, however, that these specifications should be used indiscriminately for all purposes but rather that they should serve simply as a guide in preparing the specifications for any particular piece of work. In preparing these specifications both the specifications proposed by the national engineering societies and the results of the test described in the bulletin have been taken as guides.

Definition of Sand and Screenings.—The term "sand" shall be understood to mean natural sand which will pass, when dry, a screen having ¼-in. clear openings. Similar material which is the product of artificial crushing shall be known as "screenings," and shall conform to the specifications for sand.

Suggested Classification of Sands.—Sands shall be classified as No. 1, No. 2, No. 3, plastering sand, and grout sand, the several grades being suitable for the following classes of work:

No. 1 sand is that required in reinforced concrete and in other work requiring a mortar of maximum strength and density.

No. 2 sand is that required in work not demanding maximum strength or density but still requiring a mortar of high quality.

No. 3 sand is that required where high strength or density is not a controlling factor.

Plastering sand is that for use in ordinary plastering over masonry, concrete, and wood or metal lath. Either No. 3 sand or plastering sand is of high enough quality for use in lime mortars. The latter sand should be used where the thickness of the mortar joint is such as to require grains of small size.

Grout sand is that for use in pavement fillers and other work requiring a thin, smooth, free-running grout.

Specifications for No. 1 Sand

Composition.—No. 1 sand shall consist of grains from hard, tough, durable rocks, and be free from soft, decayed, or friable material.

Cleanness.—The sand must be free from lumps of clay, loam, or other foreign material. It shall not contain more than 2 per cent by weight of finely divided clay, loam, or other suspended matter when tested by washing in such a manner as to remove all such material without removing any of the finest sand; provided, that if the strength of the mortar made from the sand is greater than 110 per cent of the strength of a similar mortar made with standard Ottawa sand, the amount of suspended matter may reach 3 per cent. This suspended matter must not form a coating around the grains to such an extent that such coating is not entirely broken up and removed from the grains by sprinkling with water or in the mixing of the mortar or concrete. The sand shall be free from oily or greasy matter in any form and must contain no organic silt.

Roughness.—The grains shall have rough, unpolished surfaces to which the cement paste will readily adhere.

Size of Grains.—The grains shall be well graded in size from the finest to the coarsest. For the greatest density not more than 8 per cent by weight, including the suspended matter, shall pass the No. 100 sieve, and not more than 60 per cent the No. 16 sieve. If maximum density is not essential and the mortar yields the required strength, these quantities may be increased to 12 per cent and 75 per cent, respectively.

Voids.—The voids in the dry sand, when well shaken, shall not exceed 33 per cent of the total volume of the sand.

Tensile Strength.—Mortar, in the proportions of 1:3 by weight, when tested at an age of 28 days shall develop a tensile strength at least equal to the strength of a similar mortar made of the same cement and standard Ottawa sand tested at the same age.

Specifications for No. 2 Sand

General Requirements.—No. 2 sand shall meet the requirements for No. 1 sand in all respects except as follows:

Cleanness.—The suspended matter shall not exceed 6 per cent by weight when tested in the same manner as described for No. 1 sand.

Size of Grains.—Not more than 15 per cent by weight, including the suspended matter, shall pass the No. 100 sieve, and not more than 80 per cent the No. 16 sieve.

Voids.—The voids shall not exceed 35 per cent of the total volume.

Tensile Strength.—The tensile strength shall equal at least 80 per cent of that of the standard Ottawa sand mortar when tested as described for No. 1 sand.

Specifications for No. 3 Sand

NO. 3 sand shall meet the requirements of No. 2 sand, except that the suspended matter may reach 8 per cent and the tensile strength be as low as 65 per cent of that of the standard Ottawa sand mortar.

Plastering sand shall meet the requirements for No. 3 sand in all respects, except that for the finishing coat it shall be of the requisite fineness to give the desired finish.

Grout sand shall meet the requirements for No. 3 sand except as follows:

It shall all pass a No. 16 sieve. The voids shall not exceed 38 per cent of the total volume. The tensile strength shall be at least 40 per cent of that of the standard Ottawa sand mortar.

Organization of Engineers

ORGANIZATION of the engineering profession is as popular a topic in England at the present time as it is in the United States. In his presidential address before the Society of Engineers in England H. C. Shenton said: "Although there is nothing wrong with engineering as a profession, there are a great many difficulties with which the engineer has to contend. The employment of persons who are not engineers to do engineering work is one of them; the employment of engineers at an improper rate of payment is another, to give only two instances. In the legal profession no unqualified person may practice as a solicitor under a penalty, yet in the engineering profession, where human life is sometimes dependent upon the work, no such safeguard is to be found. It is quite a common thing to find an overworked surveyor in a rural district receiving a salary of perhaps £60 or £70 a year dealing with the spending of very large sums of money on purely engineering work. If the profession were properly organized, such a person could not be found. If he were competent he would not be allowed to work for insufficient pay, and if he were not an engineer he would not be allowed to do the work."

Iron-Removal Plant at Urbana

Abstract of Paper Presented by Prof. A. N. Talbot to the Illinois Water Supply Association
March 11

AERATION and filtration through a coarse-sand rapid filter without chemicals are the processes involved in removing the iron from the well water supplied by the Champaign & Urbana Water Company, which contains 2 parts per 1,000,000 of iron, 40 parts of CO_2 and no dissolved oxygen, and is pumped from a fine sand stratum in drift lying 140 to 150 ft. below the surface. Long-standing trouble from crenothrix and stained porcelain led to experiments which pointed to the system adopted. The plant was put in operation July 1, 1913. Among the features of the plant are the method of measuring the raw water and the provision for variable levels of water over the sand surface as a means of regulating the rate.

Water is pumped from the wells to a receiving reservoir, where some aeration takes place by the water falling into the basin. From here centrifugal pumps raise it about 5 ft. to the filters, from which it discharges by gravity into a clear-water basin. The two reservoirs have been in use many years and the filter plant has been built between them.

FILTER DESIGN

FOUR filters, 12 x 15 ft. in plan and 9 ft. deep, of 500,000-gal. daily capacity, are located side by side, with a pipe gallery at one end. While the walls are reinforced their thickness is probably sufficient to resist the head of water without the reinforcement.

Washing takes place through separate air and strainer systems furnished by the American Water Softener Company. Two-inch extra-heavy wrought-iron laterals 6 in. center to center connect into the run of ties connected with the 10-in. collectors. The Hodkinson brass strainers, spaced on 6-in. centers, have ¼-in. diameter throats.

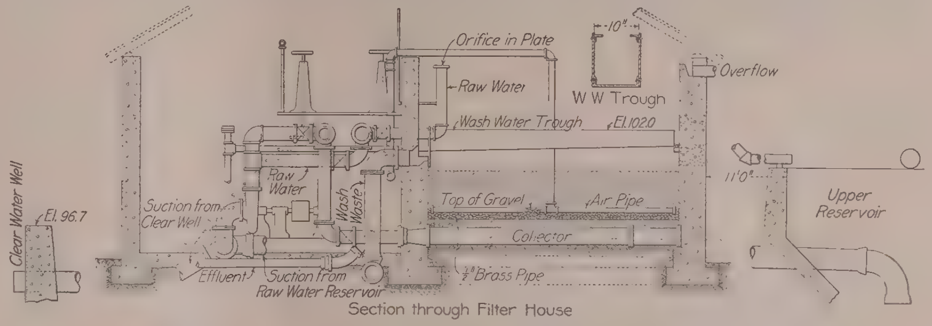
The 4-in. air main drops into the center of the filter, branching to 3 in. in diameter at the level of the gravel. The ½-in. laterals have 1/16-in. perforations, 3 in. apart, placed at 45-deg. points alternating on each side.

Each filter has two wash troughs, which rest upon supports set into the end walls, tied across by angle braces at five points in their length. These troughs, which have proved very satisfactory, are 10 in. deep at the upper end and 14 in. at the lower end. They discharge into a channel placed along the ledge in the front wall of the filter, the wall being recessed 2 in. to give a larger cross-section. The channel slopes both ways to an opening in the wall which connects with the 10-in. discharge line, which drains to the sewer or by a bypass into the raw-water reservoir.

The raw water is discharged into the filter through an orifice in the vertical pipe, rising as a jet and dropping vertically. The water is practically saturated with oxygen when it reaches the filter. The vertical pipe has a connection with the glass tube, and the raw-water valve is regulated until the desired rate of filtration is indicated on a discharge register along the tube. The apparatus forms a simple, accurate and sensitive method of determining the quantity of water discharged upon the filter.

The filter bed consists of about 30 in. of washed bank sand and 8 in. of gravel ¼ to ½ in. in size. After being placed in the filter the sand was thoroughly washed several times, and the layers of fine particles which formed on the surface were removed. Although the sand is not as uniform in size as that usually specified, the saving in cost was so much that it was thought best to use it.

As ordinarily operated, three filters have been in service and the normal amount of water used has been about 1,500,000 gal. per day. After a filter is washed the raw-water discharge valve is set to give a discharge of, say, 350 gal. per minute. This is done when the water over the filter stands at a medium level, say 2 ft. below the overflow. The effluent valve is set so as to show the amount of lost head which is usual just after washing the filters. If the head of water on the filter at starting is more than sufficient to produce the desired rate of filtration, the level of the water lowers, and if not, the level rises, until it adjusts itself to give a rate through the filter equal to the discharge upon the filter. As the filter clogs the level of the water in the filter will rise to give the necessary additional head. A range of 4 ft. in the level is available. A change in the effluent valve two or three times between periods of washing is sufficient to keep well within this range and to prevent overflow to the raw-water reservoir. It has been found that the regulation of the rate of filtration is very easily managed, and the method has proved to be satisfactory. It has advantages over the use of a controller on the effluent pipe, whose operation is hidden and uncertain, and the amount of lost head is less with this device, and the filter need not be raised to provide for such lost head. It also gives an accurate measurement of the water discharged upon each filter, which the ordinary controller does not do.



Section through Filter Unit at Urbana Water-Purification Plant

REMEDYING CLOGGING

WHEN the filters were first put in operation and while the sand was new, the filtration results were fully satisfactory. Only a trace of iron was found in the effluent. The runs were thirty hours or more and washing seemed to remove all sediment and restore the sand to its first condition. After a month or six weeks of service, however, there was such an accumulation of sticky material in the filter bed, and the sand grains had become so coated, that adequate washing was impracticable, and the loss of head through the filter immediately after the bed had been washed became very high. The intervals between necessary washing were reduced to a few hours. While the filters were in this condition large cracks would appear over the surface running well down into the sand, the appearance being much the same as that of mud cracks after drying. The effluent became poorer and poorer, until at one time not half of the iron was removed. To remedy this condition the sand from a filter was removed and given a thorough washing and returned to its place. The result was that the operation of the filter became as satisfactory as when first put in operation. The other filters were then given the same treatment. Pumping the sand through a centrifugal pump cleans it and separates the sticky material from the sand satisfactorily, and the foreign matter will then float off and drain away. Further work is required to perfect the process of this occasional thorough washing of the sand. It is thought that the sand of a filter may be washed by running it through a centrifugal pump, and then returning it to its place directly, without using much more water than is required for the ordinary daily wash of the filter. The sand of the bed has been washed twice in eight months.

At present the occasional use of a fire hose in the bed in stirring and washing the sand grains has been found to be effective, and this will extend the interval through which scouring is unnecessary. The amount of water used is not more than that required for the ordinary daily wash.

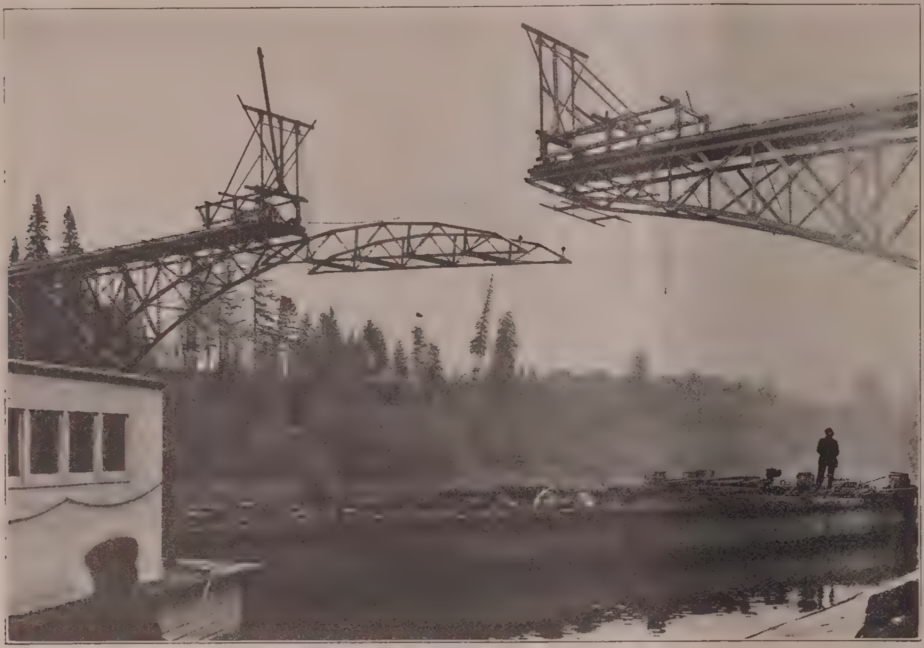
Changes have been made in the practice in the usual washing of the filter. The air wash is used as a means of stirring and is not generally put on while the wash water is being wasted. The bed is stirred manually by means of a garden rake. Two washes are given each day.

NO ASSISTANCE FROM CHEMICALS

EXPERIMENTAL work has been carried on through the co-operation of the State Water Survey with one or more of the filters to learn if the application of chemicals to the water would lessen the difficulties of washing. No advantage was found by the application of any of the chemicals used.

Clogging of the filters was the only difficulty which had been feared and now that this obstacle has been overcome the results are entirely satisfactory. The removal of iron from the water without the use of chemicals is found to be a very simple process. It seems probable that the same process is applicable to many drift well waters.

The entire work of constructing the filters was done by the water company's force and by day labor, no contracts being let. F. C. Amsbary, manager of the waterworks company, was in general charge of the work. Mr. Marquard, engineer of the water company, superintended the installation of the piping, pumping, and strainer systems and of the filter materials. G. C. Habermeyer made details of the plans and inspected the construction.



Hoisting 105-Foot Center Span from Ends of Cantilever Arms

Willamette River Bridge at Newberg, Oregon

Anchor Arms and Tall Piers Were Erected from Falsework and Center Span Was Hoisted Complete with Tackles

THE high-level bridge across the Willamette River, which is subject to heavy floods, is of interest for its attractive appearance, for the type of arrangement of trusses determined by topographical and hydrographical conditions, and for the construction methods used in building it, rather than for any unusual features of design. It connects Vamhill and Marion Counties at Newberg, Ore., where the bank is much lower on one side than on the other, necessitating a grade of 3.10 per cent in the roadway. The river at this point is subject to a variation of 45 ft. between high and low-water levels, and a clearance of 45 ft. above high water level is required over the navigable channel, where the water is about 40 ft. deep in the center.

GENERAL DESIGN

THE substructure consists of pairs of concreted cylinders with solid transverse vertical webs connecting them from low-water level to the top. The shells are made with steel plates from 5/16 to ½ in. thick, the lower sections being stiffened to resist external pressure while sinking. They have concrete copings 16 in. thick and are subject to positive reaction only, except at the shore end of the 126-ft. span, where anchorage is provided for a maximum uplift of 36 tons. Their diameters vary from 4 to 8 ft. and the river piers are 90 ft. high from the cutting edge to the coping.

The superstructure is proportioned for the heaviest country traffic with the usual concentrations, and is all of steel, except the joists, floor, and railings, which are of Oregon fir. The construction is riveted throughout, except that the shoes have pin bearings. It is assumed that the height of the piers gives them sufficient flexibility to provide for temperature movements in the superstructure, and no expansion bearings are provided for the trusses except at one end of the 105-ft. center span, which is supported directly on the top chords of the cantilever and has a sliding contact.

The shore span falsework piles, many of them more than 90 ft. long, which are easily obtained and frequently used in Oregon, were driven simultaneously on both sides of the river by a hammer in leads traveling transverse to the bridge axis on a cantilever framework projecting from the erection traveler, which moved forward on the completed falsework at the level of the lower chords of the main trusses. These wooden travelers had long booms with their vertical masts in the centers of transverse frames, braced by inclined stifflegs to short towers with platforms on top for the hoisting engines. These towers provided sufficient anchorage for the derrick booms, and also gave clearance underneath the working platform for the delivery of materials on a narrow-gage service track between the rails of the broad-gage traveler tracks. The derrick boom unloaded material from the track and handled it in front of the pile driver.

A stiffleg derrick with a 92-ft. trussed boom was installed on the bank at each end of the falsework and handled timber and other material from the shore track to the service track on the falsework. The longest piles driven in the falsework were 110 ft. long.

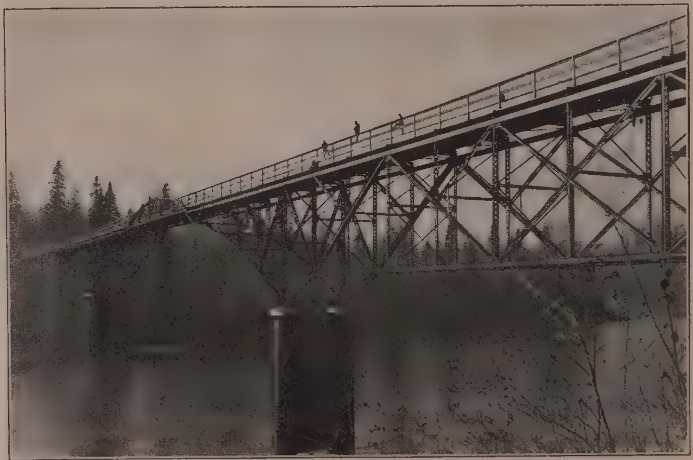
PIER CONSTRUCTION

AFTER the construction of the falsework the steel cylinders for the river piers were assembled by the travelers. The interior was pumped out and the very hard, compact sandy soil was excavated to a depth of about 40 ft. as the cylinders were sunk. After the pier shells were riveted up and braced, the concrete was deposited in them under water by a clamshell bucket and above water by special automatic dumping boxes. The pier materials were all floated out to a barge, upon which the concrete mixer plant was installed. The shore piers were built by stationary derricks.

All materials were delivered on the Newberg side of the river by a temporary connection to the Southern Pacific Railroad, and that which was required on the opposite bank was carried across on barges. After the completion of the falsework and river piers the travelers were moved back to shore and lifted from the falsework by the stationary derricks. The derricks assembled the ends of the shore spans in position and then lifted the travelers to positions on the tops of the spans. The travelers proceeded toward the center of the river, erecting the successive panels of the superstructure in advance and moving forward on them as the work was completed. The cantilever arms were, of course, erected without falsework, and all riveting in them was completed as fast as they were assembled.

Meantime the 105-ft. pony center span

Building and Concreting Steel Cylinder Piers



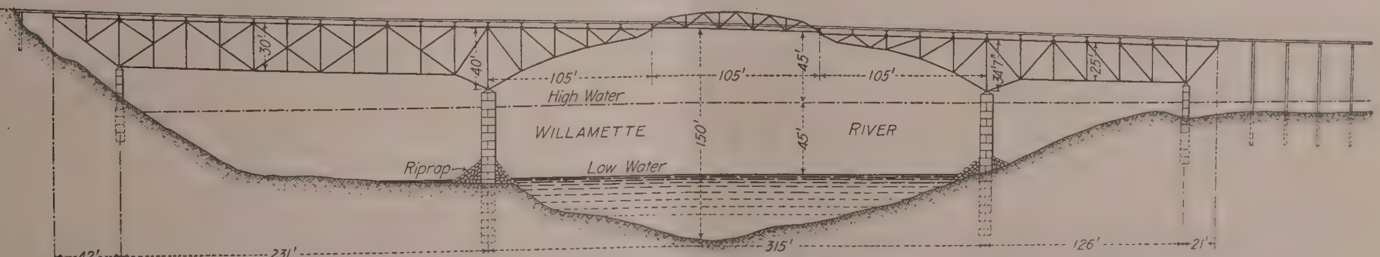
Willamette River Bridge, 735 Feet Long and 90 Feet High

Driving Falsework Trestle Piles

weighing 28 tons had been erected and riveted up complete on the barge in the river, the barge being anchored midstream immediately below the ends of the cantilever. The travelers were stripped of all unnecessary weight, although it was considered to be a superfluous precaution, and were advanced to the ends of the cantilevers. Hoisting engines were seated on the anchor spans and two tackles attached to the top of the transverse frames were connected to the ends of the trusses of the 105-ft. span. After the hitches were made, the span was hoisted 90 ft. and set in its final position on the cantilever arms in about twenty minutes, thus practically completing the erection.

The weight of the steel in the piers is about 125 tons and that in the span is 255 tons. A pile trestle approach at one end of the bridge increases the total length to about 2000 ft. All of the steelwork, including that of the foundation superstructure and approaches, was done without mishaps of any kind in 190 days. The cost of the bridge was $85,000.

The bridge was built by the Coast Bridge Company, of Portland, Ore., and erected by M. B. McClain, field superintendent of the company. The general design was prepared for the bridge company by F. W. Moore, of Portland. Steelwork was detailed and fabricated in Portland by the Northwest Steel Company.



General Diagram of Willamette River Bridge at Newberg, Oregon, Showing Main Spans and Deep Penetration of Cylinder Piers

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LUMBER CUT in British Columbia in 1913, according to a recent report of H. R. McMillan, provincial forester, totaled 1,348,000,000 ft., b. m., exclusive of piles, poles, posts, etc. He estimates that the Government revenue on the 1914 cut will be $3,000,000.

Holtwood Dam Weathers Early Ice Run in Susquehanna River

Operating Force Is Successful in Combating Anchor Ice Which Started to Form on February 12

WARM weather and rain on Jan. 30 and preceding days have caused the ice over the entire area of the Susquehanna River to break up. All the up-river gaging stations of the Pennsylvania Water & Power Company reported ice moving out on high stages on Jan. 30; on the afternoon of the following day the ice field in the storage lake at the Holtwood power station commenced to move. During the night of Jan. 31 the up-river ice followed in large cakes and the ice run continued until Feb. 3. The maximum stage, recorded on Feb. 2 at 4 a. m., was 8.4 ft. over the dam crest, equivalent to a flood of about 220,000 sec.-ft.

Previous ice runs and freshets had produced higher river stages repeatedly since the completion of the Holtwood dam. The greatest flood occurred on March 29, 1913, reaching a height of over 13 ft. at the dam crest, an equivalent of about 440,000 sec.-ft. During none of these floods was the operation of the plant affected to any extent, beyond the usual lowering of head incident to high water.

ICE PROTECTION

ICE protection at the Holtwood plant is said to be excellent and during the four winters of its operation no surface or slush ice has been carried from the river into the gate-house or even into the forebay. The construction of the dam, it is believed, has had a deterrent effect as regards the previously frequent formation of ice jams in the river below. Formerly large packs and islands of up-river ice were carried along in the main river to its shallow sections, a few miles above the mouth, where they grounded and caused jams; at present all the up-river ice, in falling over the dam, is broken up into small pieces which can float through clear to the bay under a much lower river stage than was formerly required for the big islands of ice. This difference was illustrated impressively by a tremendous ice jam of several miles extent at Port Deposit in the winter 1909-1910 which destroyed many houses, blocked the railroad traffic for about two weeks and caused large damage also to other property along the river below Holtwood. In the following winter the dam was completed and never since has there been even a tendency for the formation of one of the much-dreaded ice jams. In former years, at the approach of the ice flood, the inhabitants of the low-lying houses in the threatened districts used to take refuge in the hills, but they have abandoned their fears since the erection of the dam and feel safe in their houses even during the ice floods.

Holtwood Dam During Recent Flood

Following this year's first ice run, the river dropped rapidly and, on Feb. 10, the discharge was approximately 50,000 sec.-ft. The weather had changed from fair to cloudy and cold, and, due to the absence of an ice sheet over the storage lake, a very interesting phenomenon occurred during the morning hours of Feb. 12—the formation of anchor ice in the river.

The night was cold and clear, the temperature dropping down to —14 deg. Centigrade during the early morning hours. The power house operating force, on the lookout for anchor ice, placed test pieces in the forebay and inspected them at frequent intervals. No accumulation of ice was noticed, until suddenly at about 7.30 a. m. small pieces of anchor ice commenced to adhere to the steel intake screens, reducing their free flow section. By prompt manipulation of the intake screens—partly pulling them out and party suspending them from the floor level—the operating force succeeded in restoring most of the units to full output in about two hours.

TEN CONCRETE-ROAD ESSENTIALS were given by Ernest McCullough, consulting engineer, of Chicago, in a paper presented at a recent meeting of the Illinois Society of Engineers and Surveyors, and are as follows: (1) Intelligent supervision, (2) careful selection of materials, (3) proper proportioning, (4) proper mixing, using batch mixers only, (5) moderate use of water, (6) avoidance of a mix leaner than 1:2:3, (7) use of reinforcing on wide roads and over filled spots, (8) use of combination metal and fiber expansion joint fillers at intervals of about 25 ft. across the road, (9) avoidance of longitudinal joints, and (10) a visit to some concrete road under construction before attempting to construct one.

Three-Axle Road Rollers to Prevent Surface Waving

Theory of Wave Formation in Pavements Advanced by English Highway Engineer to Account for Road Deformation

THE theory that the damage caused by fast, heavy motor traffic is due to the impact lent by the bounding motion of the machines rather than to the actual wear, referred to in an article on "Traffic and Wear of English Highways" in the Engineering Record of Dec. 6, 1913, page 638, has been developed at length by Col. R. E. B. Crompton, of London, in a recent paper read before the Institution of Mechanical Engineers. Declaring that the vehicle and the road should be treated as a railway with its rolling stock, the two being interdependent, Colonel Crompton proceeds to discuss the causes of road deformation as he sees them. His remarks on the reason and remedy for surface waving are here abstracted.

Soon after the formation of the English Road Board the author was engaged in preparing specifications for a number of trial lengths of road-surfacing material to be tested in competition near London. In measuring and recording the rate at which these surfaces were lowered by wear he soon found that, although at most points the level was lowered, in others the surface had actually risen. In following out this matter the author found that this occasional raising of the surface immediately under the cross-contour line of measurement was due to the fact that the point coincided with the crest of a wave which had been formed; because when a straightedge was laid in the direction of the traffic at right angles to the cross-contour line it soon became evident that the lowering of the surface was not due to wear but chiefly to "deformation," that there was really a transfer of the road material in the direction in which the traffic was rolling in some cases from a point underneath the wire to a point further down the road, but that whenever a rise of the surface was indicated immediately under the wire this was due to the contour measurement happening at this point to be taken across the crest of a wave.

RESULTS OF VEHICULAR PERCUSSIVE ACTION

THESE observations added to many others taken on other roads have inspired the author with the following convictions: The deformation of road surfaces caused by modern traffic is due to the rolling action of the wheels at the speeds now employed for self-propelled traffic being no longer true rolling but more in the nature of a rhythmical percussive action, the wheels striking the ground at regular intervals. This percussive action has always a tendency toward re-forming the original flat or approximately flat surface into a surface having well-defined waves. This wave deformation can become so intense as to reach a point where it causes the road to break up, namely, when the crests of the waves become so high and the depressions are so deep that the oscillation or pulsation reacts on the vehicle; the road thus becomes so rough to drive over that it is necessary to re-form the surface.

This tendency toward wave formation had been often noticed by road surveyors, but the causes of it in the past were put down to original unequal spreading of the road material, to unskilled rolling, irregular consolidation, insufficient or irregular foundations, excessive watering, in fact to many causes other than the one now brought forward by the author.

The next point requiring investigation was to determine, if possible, the manner in which the materials forming a road surface are moved into new positions when the wave formation is in progress or complete. When a wheel rolls over any surface, the individual particles of which that surface is composed must be rocked to and fro by the rolling action of the wheel, and it is practically certain that this rocking is greatly intensified when pulsating or percussive action of the wheels is substituted for smooth rolling.

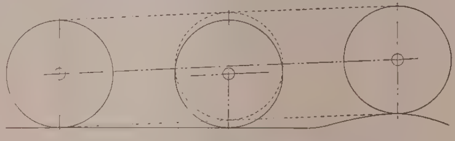


Fig. 1—Front Roller Mounting Wave

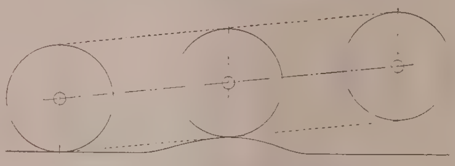


Fig. 2—Center Roller on Summit

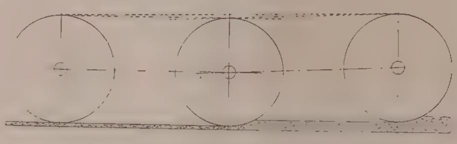


Fig. 3—Rolling Fresh Material

Action of Three-Axle Road Roller

It will be readily seen that, with roads made up as they now are with particles of regular size, they must in the action of rocking abrade one another and so wear away their angles and gradually alter their shape from the sharp angular form of the new road material until they approach a spherical shape. In a well-designed newly made road of the existing type angular pieces of stone of a definite size or gage are used, the voids between these stones being partly filled with smaller angular pieces and with sand and fine material, so that when the whole is consolidated by the roller, the rocking action of the wheels of the traffic is resisted to some extent by the angular interlocking of the stones and sand. As the stones lose their angles and become rounded, a time comes when they can actually roll over and thus transfer themselves to new positions, being propelled to these new positions by the percussive action of the wheels. This has a greater effect on the larger than on the smaller stones, so that in practice, when one examines cross-sections of the crust of any roadway that has been subjected for some time to the action of traffic and that has acquired a waved surface, one finds the smaller rounded stones underneath the troughs and the larger stones underneath the crests of the waves. The author's observations on this matter have been made on a very large number of cross-sections of roads exposed by the operations of the water board and other authorities when laying pipes or in similar road operations.

INFLUENCE OF HARMONIC VIBRATION

AGAIN, commercial vehicles now consist of large fleets of wagons or vans which are practically identical in all their harmonic features, and as these run over roads as regularly as a train service on a railway they have a severe harmonic effect on their surface. If we examine the effect of a line of motor omnibuses all having the same characteristics of total weight, of unsprung axle weight, period of springs, length of wheelbase, vibration of engine, traversing a road at approximately the same speed at regular intervals of time, it is not surprising to find that wave formation amounting to cross corrugation is rapidly set up, that roads of the old type become broken up from this cause in a few months, and that the wave formation produced is very regular and definite in wave length.

In considering what might be done to improve the vehicles so as to minimize their tendency to deform the road in this way the author's ideas were first directed to the small waves which are always found to some extent on newly formed road surfaces. The chief reason why no surfaces but those of wood pavement, or of the sheet asphalt laid with a trowel and adjusted by hand beaters, are free from initial harmonic waves is that when an ordinary two-axle roller is first brought on to newly spread road material it pushes the material forward until a certain resistance to forward movement is encountered, and then rolls over the accumulation thus formed in front of it. This alternate action is periodic, and the wave length depends on the diameter of the roller wheels, the total weight, the distance between axles, and to some extent on the speed at which the rolling is carried out. It is found to be much easier to roll to a surface of small-wave height certain soft road materials, such as blast-furnace slag or some of the limestones, than the harder and less compressible granites and basalts, but in no case is the finished surface ever truly flat and waveless. When the traffic comes on to the road there is little doubt that the small waves left by the rolling serve as a starting point for the shorter-period waves eventually formed by the traffic itself; and as it appeared to the author that all two-axle vehicles must cause this action, it occurred to him that it would be better to commence by modifying the design of the rollers themselves to produce a non-wave-forming roller. He has adopted the three-axle principle, which he believes might with advantage be extended to all vehicles carrying heavy loads.

THREE-AXLE ROLLER

THE idea of designing this roller came from studying the three-axle wagons used by Colonel Renard for the well-known Renard train. Colonel Renard's ideas of perfect road transport were that all the vehicles of his train should be provided with three axles, and his experiments showed that the Renard train was exceedingly easy on the road, as the rolling resistance, and, therefore, the power required to propel the train measured by its fuel consumption, was found to be very small. Colonel Crompton designed and had built such a roller, which, he states, has certainly produced surfaces freer from waves than has heretofore ever been the case.

In order to obtain a perfect leveling action of the rolled surface, the weight taken by the three rollers must constantly vary so that it can exert maximum pressure on the high places and a minimum pressure on the low ones. At the same time there must never be less than sufficient weight on the center driving roller to enable it to have the required driving adhesion. These conditions are met in Colonel Crompton's design by mounting the center roller on springs, in such a way that it can fall below, but cannot rise above, a fixed point relative to the front and rear rollers. The action of the rollers is then as shown in the diagrams. In Fig. 1 the front roller is seen on the summit of a wave or high place, the center roller having sunk below its normal position, which is indicated by the dotted lines; when the center roller passes over the same summit, shown in Fig. 2, it takes practically the whole weight of the roller. If the center roller were not provided with springs as described, the rear roller would tend to leave a depression when in the position shown in this figure. Fig. 3 shows the action of the machine when rolling freshly laid road material; it will be seen that the rolling surface of the center roller is slightly below the level of the other two. This gives a very light pressure during the first time of rolling, which gradually increases each time the roller comes back on to the cooler and harder material already rolled; this is due to the fact that, as the road surface becomes less yielding, the weight becomes more concentrated on the central roller, giving the much-desired effect, just as if a light roller was first employed followed by a heavier one, but the change being more gradual. The difference in the level of the rollers is adjustable from the front steering head and extends over a range so sufficient that, if necessary, the rear roller can be permanently raised from the ground, concentrating 90 per cent of the total weight on the center roller. The front roller always has sufficient excess of weight to give steering effect. In Colonel Crompton's roller the wheelbases are not equal. This is purposely arranged as a further precaution against the possibility of producing recurring waves. In the present design the diameter of the center roller is 3 ft. 6 in., and that of the end rollers 3 ft., but in the new design the center roller has been altered to 4 ft. The width of the rollers over all is 4 ft.; the long wheelbase, 8 ft., and the short wheelbase, 6 ft. 6 in. The distribution of weights can be varied by the hand-wheel adjustment, between the limits given in the table, with corresponding rolling-pressure variation of from 80 lb. up to 550 lb. per inch width of roller. All quantities have been converted to United States equivalents.

Varying Rolling Pressures in United States Pounds

	Front axle	Center axle	Rear axle	Total
Without water ballast	1,904	19,040	0	20,944
	7,616	7,616	5,712	
With water ballast	1,904	23,856	0	25,760
	9,212	9,212	7,336	

Discussion of Colonel Crompton's paper was reported in the "Engineer" of London, from which these extracts are taken.

Mr. A. Dryland said that so far as he had been able to inspect the work of the three-axle roller it did seem to give an evener surface than the ordinary type. As regarded the causes of wave formation on roads, he held that the weight of the individual vehicles was an important factor. On some of the roads near London carrying much traffic of the delivery van type nine-tenths of the deformation was to be found on the out-journey side of the road, which carries by far the greater loads.

Mr. C. J. Jenkins confirmed the author's observations on the formation and movement of road waves, and agreed with him that the size of the wheels and the length of the wheelbase of the traffic materially affected the phenomenon. As regarded the shape of the stones used in road construction, he stated that cubes were least satisfactory, because of all shapes they lent themselves most readily to the formation of spheres. The value of slag as a roadmaking material was, he thought, due to the fact that, while it was less elastic than granite or basalt, it gave way under pressure, and one piece settled down and fitted into the shape of its neighbors and did not tend to roll over them.

QUESTIONS

SEVERAL questions were directed at the author: Did the surface waves advance and did they tend to break as the crests gained on the troughs? How could harmony of action take place with vehicles differing so widely in length of wheelbase and weight?

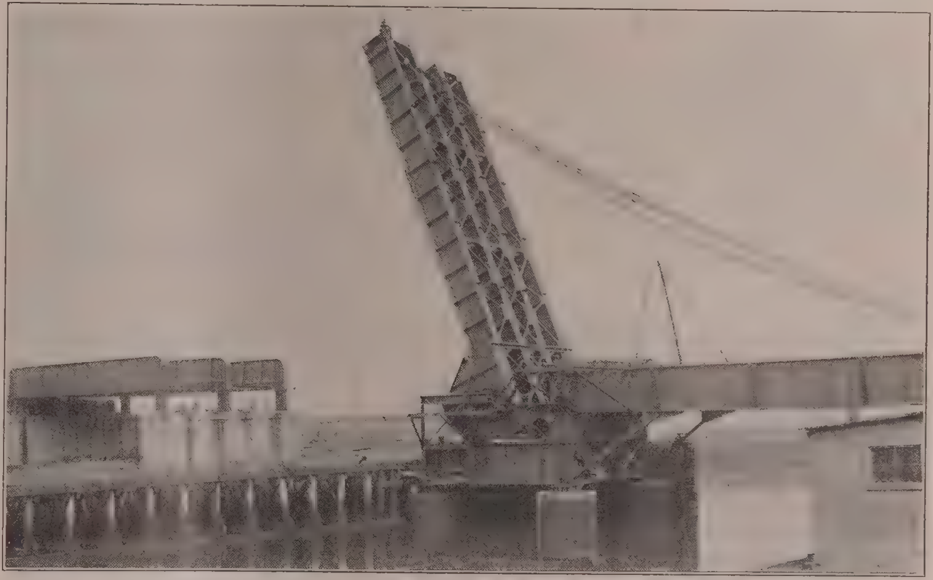
In replying, Colonel Crompton said that the waves did advance in the direction of traffic moving in opposite directions on the two sides of the road; but whether the crests broke like sea waves had not been determined. In assuring his audience that harmonic action did enter very materially into the development of road waves, he instanced the case of the road from Golder's Green Station to Hendon, where the traffic was almost entirely composed of motor omnibuses and where deformation had occurred very quickly after the road had been relaid. He had noticed repeatedly that any projecting bump in the surface could start a ripple, which, while traveling along in the direction of the traffic, soon developed into a wave.

Lifting Bascule Span with Derrick

Bridge of 175 Tons Hoisted and Revolved About Its Heel in Twenty Minutes

WORKING only on Saturday afternoons and Sundays of two consecutive weeks a force of twenty men assembled and bolted up in horizontal position on their piers the four main 5-ft. deep longitudinal plate girders, floorbeams and stringers of the double-track, 46-ft. Scherzer bascule span of the Long Island Railroad over Dutch Kills Creek, Long Island City. The girders were bolted up in horizontal instead of vertical position—the latter being the more common practice—to save time and expense.

As it was necessary to maintain the channel open to navigation while the machinery for the operation of the bridge was being installed and adjusted, the span was revolved into a nearly vertical position as soon as it was completely assembled by the 125-ton, 80-ft. boom of a Merritt & Chapman lighter. The thirteen-part main tackle of the boom was connected to the two center girders by a pair of 2-in. chain slings, and two other seven-part tackles were attached to the outside girders by single 1½-in. chain slings.



Bascule Span Temporarily Maintained in Open Position by Guys

After the connections were made the span, weighing 175 tons, was hoisted and revolved about its heel in twenty minutes, the vertical reaction on the tackle being estimated at 97 tons.

While the field rivets were being driven the span was maintained three weeks in the open position, where it was guyed by a 1½-in. Hercules steel cable, adjusted by a seven-part tackle attached to the two center girders and by two 1-in. cables adjusted by steamboat ratchets, one attached to each of the side girders. All of these guys were anchored to the girders of the approach span.

While the span was maintained in the open position and the machinery was being adjusted the counterweight was installed.

The bridge was built under the direction of J. R. Savage, chief engineer, and Frederick Auryansen, bridge engineer, of the Long Island Railroad. It was fabricated by the Penn Bridge Company and was erected by Robert Dunseath, of New York.

Refuse Collection and Disposal in Chicago

Abstract of Report by Irwin S. Osborn and John T. Fetherston Recommending a Combination of a Central Reduction Plant and Local Incinerators

REDUCTION of garbage proper at a central plant, incineration of the rubbish at fourteen loading stations and disposal of ashes in fill are recommendations made by Irwin S. Osborn and John T. Fetherston to the Chicago City Waste Commission in a report submitted March 31. After studying the proposition from every angle with a large corps of assistants since Jan. 16 it was concluded that on the grounds of sanitation and economy the treatment of garbage by the reduction process is the logical method to pursue. Land fills need ashes, street sweepings and basin cleanings. Rubbish, as far as possible, should be burned and the residue sent to land fills. With modern plants properly designed for the treatment of the different classes of wastes and controlled by an effective organization, the program recommended will result in the elimination of nuisances due to dumps, odors from the reduction plant and nuisance due to the collection of waste in open vehicles.

SIX PROJECTS CONSIDERED

FOR the disposal of refuse six projects were considered. Project A involves total incineration of the combined garbage and rubbish, but separate collection of ashes. Eleven loading stations with incinerators at each would serve an equal number of districts.

Project B is the same as A, except ashes also would be collected and burned. Project C is similar to A as to collection, but assumes nine collection districts, in seven of which incinerators would adjoin pumping stations for utilizing the steam produced.

Project D, the one recommended, consists in the disposal of garbage in a central reduction plant and the disposal of rubbish in small incinerators located at each station, except in the district comprising the Eighth and Ninth Wards, which is provided with an incinerator for total destruction of all garbage and rubbish. The city is divided into fourteen collection districts, with a loading station in each district for transfer of the material by trolley, barge, auto truck or wagon. It contemplates the separate collection of ashes, rubbish and garbage, except in districts where total incineration is contemplated, where all ashes are to be disposed of by fill.

Project E is the same as D, except the reduction works would be located on the main drainage canal near the western city limits. Project F differs from D only in the disposal of the rubbish, which would be burned in one of four incinerators.

For Chicago in its present state of development the use of inorganic wastes for grading land in need of improvement will undoubtedly afford the logical solution for the disposal of clean ashes. Street sweepings, catchbasin cleanings, wastes from road repairs and earth from excavations must likewise be disposed of by land fills. In fact, no matter what system of disposal is adopted, land fills must be provided and will be continued in use until the cost of haul exceeds other means of final disposition. It is fortunate that Chicago will have for a number of years to come land within the city limits available for the disposal of inorganic or partly mixed wastes.

Garbage is the most difficult material to dispose of without nuisance, and the solution of the waste-disposal problem for Chicago centers on the disposal of garbage, in so far as sanitary conditions are concerned. Some method of treatment is essential for organic wastes, as disposal by fill is out of the question. The choice of processes lies between incineration and reduction.

In Chicago particularly, the length of haul for collection and delivery of the wastes, next to the sanitary requirements, is the most important element in the disposal problem. From the citizens' standpoint the collection system is of more importance than the disposal method, and the type of receptacle for holding the different classes of wastes is of even greater moment to the householder. The whole question of house treatment, collection, transportation and disposal of the three main classes of household refuse (ashes, garbage and rubbish) by every practicable plan for Chicago has been canvassed from every angle, and the relative merits of the various methods have been discussed both from the sanitary and economical standpoints. No untried processes were considered, and the estimates of cost or revenue have been fixed on a conservative basis. No cure-all is proposed, but a practical working program, susceptible of variations to meet changing conditions and to keep pace with the growth of the city, has been outlined in sufficient detail to prove its advantages over other systems.

COSTS COMPARED

THE estimated cost of separate collection, reduction of garbage, incineration of rubbish and dumping of ashes is so much less than the incineration projects A, B and C that there is no question as to the economy of the combined methods for the city.

In addition to the six projects detailed in the report, two other projects—one proposing total incineration in one central plant and another a combination reduction and incineration at a central plant—were developed to a point where it was quite apparent that the cost was much higher, and without compensating advantages, when compared with the projects already considered.

Under project D, that recommended, the service to be rendered the people of Chicago will be increased approximately 50 per cent, as represented by the frequency, regularity and amount of collections. The cost of collection, transportation and disposal of refuse under existing methods for 1912 was approximately $1.87 per ton. In 1920 by the method recommended the cost per ton is estimated at $1.48, or more than $500,000 for the 1,307,490 tons of material to be collected and disposed of when compared on the same basis for 1912.

Estimated capital cost for project D is $3,513,000, divided into collection equipment, $683,500; stables, $660,000; loading station, $600,000; street cars, $140,000; water transportation equipment, $100,000; motor trucks, $72,000; incinerators, $395,000, and a new reduction plant at the site of the existing one, $862,500. The annual cost of operation and maintenance and fixed charges are: Collection, $1,766,286; loading stations, $92,713; street-car transportation, $226,724; water transportation, $56,695; motor transportation, $58,259; incinerators, $88,892; reduction works, $372,192—a total of $2,661,761. Sale of grease and tankage is estimated to bring an annual revenue of $725,654, making the net annual cost $1,936,107.

BASIS OF ESTIMATES

ESTIMATES for the various projects considered were all made on similar bases. The cost of collection was computed by taking the sum of the estimated cost of loading and the cost of haul. The cost of loading was estimated for either combined collection or separate collection, according to the method of disposal. The cost of haul was determined from the ton-mile haul of each class of refuse collected separately or combined. The ton-mile haul was computed by multiplying the estimated tonnage collected in each district by the average haul to the point of disposal or loading station. To determine the average haul the distance was measured from a point midway between the center of area and the center of population of each collection district, following right-angle street lines to the point of disposal or loading station. The cost per ton-mile was computed by allowing a travel of 3 miles per hour per team, the cost of team and driver being estimated at 75 cents per hour, with allowance for time to discharge load. The estimates were verified by time studies and cost data available for similar work.

The cost of collection was computed, assuming a uniform production of each class of waste. This will not hold true in actual practice, due to various reasons, such as character of population or other factors that would affect the production in various districts. The uniform production was assumed for each project considered so that the relative results would be constant.

The loading stations were fixed at locations most suitable for the purpose, and the cost of the land was taken from a former report by the bureau of efficiency, but the cost of buildings and appurtenances was increased to provide modern equipment and more permanent construction.

Present cost for similar service was assumed for trolley and barge transportation. Fixed charges included interest at 5 per cent and depreciation based on a sinking fund which would equal the cost of the plant during the estimated life of the various elements, the interest being assumed at 5 per cent. The cost of operating incinerators was based on the cost of labor, repairs and attendance on electrical equipment per ton of material handled for the year 1920.

Operation of the reduction plant and its cost were based on overhead charges, labor, fuel, supplies, repairs and renewals required to dispose of quantities produced in 1920.

The capital investment for incinerators and the reduction plant was based on detailed estimates of current unit prices. The capacity of the various disposal plants was based upon the estimated maximum production of the different classes of refuse for 1913.

The grease recovered from garbage was estimated at 3.25 per cent of the total weight of the garbage as delivered, while the tankage recoverable was estimated to be 14 per cent. The average price for tankage will vary from $6 to $10 per ton, but the price was taken at $7. Garbage grease during the last seven years has been sold for 4.13 cents per pound. In estimating the value of grease for Chicago 4 cents was used.

Irrespective of what plan is adopted for disposal, it is conceded that from a sanitary standpoint all wastes should be collected, and the results show that the best results are obtained when it is done at public expense. A combined collection of all waste has the advantage in that it requires only one receptacle and one type of collection equipment. The housewife will prefer the combined collection for convenience. The separate collection of garbage requires separate receptacles and additional equipment of different types over that required for the combined collection.

When combined collections are made more frequent trips to collect ashes and rubbish are necessary. The ability of men and teams to collect refuse does not depend on the amount collected but upon the number of stops, distance of travel and the number of receptacles to be handled.

Where separate collections are made there is a tendency to throw garbage into the ash receptacle or rubbish and ashes into the garbage receptacle. To obtain the desired separation will require the strict enforcement of ordinances, as well as the regulations or rules of the collection department. Rules relating to sanitation in connection with plumbing and other health measures are rigidly enforced in the majority of American cities, and with the same amount of energy and education in connection with house treatment of refuse similar results should be realized.

DISPOSAL METHODS

A DESCRIPTION is given of the various methods of disposal, but only four are considered at all adaptable to Chicago, namely, dumping on land, disposal by fill, incineration and reduction. The first two methods were considered suitable only for the disposal of the residue from incinerators, street dirt, manufactured wastes and non-decomposable material. The American types of incinerators do not permit their operation at sufficiently high temperature to insure complete combustion of the gases, and, states the report, in operation the garbage is destroyed more by distillation than by oxidation. In the operation of incinerators properly designed to maintain a high temperature it has been demonstrated by the plants now in existence that a revenue can be obtained from the production of steam and the utilization of clinker.

The criticism of reduction works has been due to the manner in which the plants have been constructed and operated, and the same criticism will continue as long as the work is done by contract without restriction. It is only natural for a contractor who obtains a contract in competition without restrictions to conduct the work at the least cost with the largest remuneration possible. The result will be inferior equipment and little attention will be paid to the sanitary features either in the design or operation of the disposal works.

The greatest cause of complaint will arise from the gases given off from the vents on the digestor tanks or the vapors given off by the dryers. The manner in which the gases can be deodorized consists in condensing the soluble gases and passing the insoluble gases through furnaces where the gases are heated to a sufficient temperature to deodorize them. From experiments and tests made on a special high-combustion furnace fitted up so that the gases were passed through the furnace at various temperatures it was found that the insoluble gases from the cooking tanks were deodorized when heated to a temperature of 1200 deg. Fahr., and very little odor could be noted after heating them to 1000 deg. Fahr. The deodorizing of gases from the digestors or cooking tanks is not difficult, due to the small volume, as the material while being cooked is sealed in the tank and the gases escaping are passed through closed vent lines to condensers, which in turn discharge into a sealed hot well, where the gases are trapped. The gases from the dryers can be deodorized in a similar manner, but the volume of gases is so large that it will require large furnaces operated at an almost prohibitive cost.

One of the largest factors in developing the work in connection with the disposal of garbage by the reduction method has been the increased demand for the by-products, now estimated at about 30,000 tons of grease and 150,000 tons of tankage per year, having an average market value of $3,500,000.

When comparing the relative quantities of garbage, ashes and rubbish collected in Chicago with the same production per capita in other cities it is noted that Chicago has a very much smaller production. This is accounted for on the grounds of variable service, private collection, no collection and insufficient appropriation. In 1913 98 lb. per capita per year of garbage were collected and 550 lb. of ashes and rubbish. Of eight cities varying from 180,000 upward the pounds per capita range from 160 to 236. Chicago, therefore, it was estimated, in 1920 will have a quantity of 150 lb. per capita.

ANALYSES

PREVIOUS to making studies for this report there were no available data for Chicago as to the mechanical and chemical analysis of ashes and rubbish. During January and February twenty mechanical analyses were made at several dumps on representative loads from various collection districts. Average results indicate 49.88 per cent fine ash, 34 per cent coal cinders, 11.59 per cent clinker, 0.97 per cent glass, 0.87 per cent metals, 1.70 per cent rubbish, and 0.99 per cent garbage. A comparison was made with the Borough of Richmond for the month of January covering a period of five years. There fine ash was 53.5 per cent; coal and cinders, 27.1 per cent; clinker, 2.9 per cent; glass and metal, 6.6 per cent; rubbish, 9.9 per cent, and garbage nothing.

Messrs. Osborn and Fetherston were assisted in collecting the information and preparing the report by Samuel A. Greeley, Richard T. Fox and W. R. Hillyer, also by the City Waste Commission, the bureau of streets, the bureau of efficiency of the Civil Service Commission and other city departments.

Operating Results of Water-Purification Plant at Columbus

Notes and Tabulated Figures Based on Five Years of Service, Abstracted from the Official Report for 1913

FIVE years' comparative results of the operation of the Columbus, Ohio, purification plant are contained in the 1913 report of the Division of Water. There are also a description of the mounted electric apparatus for thawing out water pipes (see Engineering Record of Feb. 22, 1913, page 217), an account of the killing effect on bacteria of overdosing with lime, which was used to such good advantage during the March floods of last year (see Engineering Record of April 12, page 395, and Sept. 6, page 257, 1913), and a description of the new lime-storage bins and weighing apparatus (see Engineering Record of July 5, 1913, page 11) which reduced the handling time from four hours and fifty-three minutes per ton to three hours and twenty-two minutes per ton—a cost saving of 55 cents per ton.

Taking typhoid fever as an index of the efficiency of the sanitary purification of the water during 1913, there were 191 cases—170 resident and 21 non-resident—of which 20 resident and 18 non-resident proved fatal, making death rates per 100,000 of 10 and 9.03 respectively.

Lime, soda ash and sulphate of alumina are used to soften and purify the water. In 1913 lime reduced the temporary hardness due to bicarbonate of cal-

AVERAGE MONTHLY CONDITIONS AND RESULTS OF OPERATION OF THE WATER-SOFTENING AND PURIFICATION WORKS OF COLUMBUS, OHIO

			Chemicals applied, grains per gal.			Color		Turbidity			Total hardness			No. bacteria per cc. whole numbers			Hypochlorite of lime ppm.
1913	1,000,000 gal. per day filtered	Wash water, per cent	Lime	Soda ash	Coagulant	River water	Filtered water	River water	Settled water	Filtered water	River water	Settled water	Filtered water	River water	Settled water	Filtered water	available cl.
January	16.0	2.7	6.3	2.9	2.9	37	7	198	16	0	170	103	89	29,326	1,256	110	.15
February	17.5	2.1	7.7	6.0	1.8	24	3	32	3	0	291	107	89	4,578	22	4	.20
March	15.9	2.3	6.0	2.5	2.4	28	5	280	15	0	167	91	79	33,859	49	19	.11
April	16.1	2.4	6.6	2.6	2.0	38	6	178	12	0	188	89	80	4,764	64	18	.22
May	17.1	1.7	8.5	5.2	1.1	21	2	20	0	0	296	95	84	421	90	15	.21
June	19.5	1.2	8.9	5.9	0.9	28	5	21	0	0	301	91	83	372	235	6	.20
July	20.1	1.2	8.2	5.1	0.7	26	6	18	0	0	278	94	85	158	46	4	.19
August	20.6	1.5	7.4	5.7	0.7	29	9	18	0	0	267	91	84	197	31	6	.16
September	19.9	1.6	7.4	7.5	0.8	19	8	16	2	0	303	108	99	232	3	2	.20
October	18.0	1.5	8.3	8.6	1.7	16	5	14	11	0	322	103	91	423	7	0	.20
November	17.2	1.6	8.1	8.8	1.6	15	3	20	5	0	317	113	97	949	17	1	.16
December	16.6	2.1	8.2	11.7	1.7	21	6	11	7	0	357	117	98	442	11	1	.18
Average for year	17.9	1.8	7.6	6.0	1.5	25	5	69	6	0	271	100	88	6,310	153	15	.18
Max. for year	24.4	6.5	13.1	13.1	7.7	55	15	2000	53	5	392	148	124	550,000	12,200	1200	.33
Min. for year	11.3	0	0	0	0.4	10	1	7	0	0	43	72	60	12	0	0	0

AVERAGE YEARLY RECORD OF OPERATION OF THE WATER-SOFTENING AND PURIFICATION WORKS OF COLUMBUS, OHIO

1909	13.6	4.1	7.9	3.8	1.76	42	8.7	86	..	0	253	105	93	9,235	636	120	...
1910	14.5	2.3	7.6	5.3	1.02	29	7.0	37	6.3	0	270	95	85	9,338	117	24	.26
1911	14.9	1.3	7.5	4.3	1.57	28	7.0	68	3.2	0	245	90	84	11,470	172	55	.30
1912	16.8	2.1	7.0	3.4	1.90	28	6.4	84	7.5	0	222	90	80	19,210	398	14	.30
1913	17.9	1.8	7.6	6.0	1.5	25	5.0	69	6	0	271	100	88	6,310	153	15	.18

cium and magnesium from 160 to 61 parts per 1,000,000. Soda ash, added to precipitate the permanent hardness, removed 83 of the 111 parts per 1,000,000 in the river water.

Sulphate of alumina is ordinarily used as a coagulant, but at this plant it is also used to reduce the temporary hardness of the water. From ½ to 1 grain of alum added to the settled water before it goes to the filters will reduce the alkalinity from 20 to 30 parts per 1,000,000, whereas, theoretically, 1 grain of alum should only reduce the temporary hardness about 8 parts per 1,000,000.

A long series of experiments has been started in order to find out, if possible, just why such large reductions in alkalinity follow the application of alum to the softened water. Data available at the present time seem to indicate that the magnesium present in the river water combines with the lime and soda ash to form a colloidal precipitate of basic carbonate of magnesium and that the flocculent precipitate formed by the addition of alum drags down this colloidal precipitate, thus reducing the hardness.

The colon bacillus was isolated during 1913 from 204 1-cu. cm. samples of raw water. In the filtered-water samples it was found twice in 1-cu. cm., fourteen times in 10-cu. cm, and nineteen times in 50-cu. cm. portions.

COSTS

OPERATING expenses at the purification plant during the year were $23,760.13 for labor, $69,999.06 for chemicals and $7,168.36 for supplies, a total cost per 1,000,000 gal. treated of $15.11. The increase over 1912 was due to a harder water, greater consumption and higher wages paid for labor. In 1912, 5774 tons of chemical were handled, against 7234 tons in 1913.

The cost of pumping and purifying was $25.41 per 1,000,000 gal., while the total cost of supplying water figured on actual running expense was $47.31, an amount increased to $55.50 by adding the payment of interest on bonds.

Columbus had an estimated population in 1913 of 207,000, with 195,000 persons estimated as being supplied with 88.2 gal. per capita. The percentage of consumption metered is 59.89, but the percentage of services metered is 94.34. Each tap passed an average of 562.8 gal. More than 25 per cent of the water is unaccounted for.

With each pound of the Hocking nut, pea or slack coal, costing $1.44 per ton, delivered, 403.4 gal. of water were pumped. The total cost of pumping per 1,000,000 gal. was $8.61.

Jerry O'Shaughnessy is superintendent of the waterworks and Charles P. Hoover chemist in charge of the purification works.

Hoist Signals

SOME time ago the American Hoist & Derrick Company had a letter from a Government engineer asking for a practical list of hoist signals for hoisting engineers and derrick men. After numerous discussions with experienced engineers the following code was adopted and is said to have worked out well: For booming up, thumbs up; for booming down, thumbs down; for raising load, wave hand up; for lowering load, wave hand down.

Comparisons of Systems of Flood Control

Second Paper in This Series, Dealing with Quantitative Analysis of By-Pass, Reservoir and Levee Methods on Sacramento and Mississippi Rivers

By H. A. PETTERSON
Civil and Hydraulic Engineer, San Francisco

THIS paper will offer some construction quantities involved in the principal systems of flood control for the Sacramento and the Mississippi basins. The quantities are, of course, approximate, as absolutely accurate quantities cannot be determined until comprehensive surveys are made. Without surveys the best that can be done toward estimating new reservoirs is to base the estimates upon an average of other reservoirs which have been constructed or carefully surveyed. To determine the area of land that would be submerged by reservoirs it is necessary to know the mean or effective depth or ratio of effective depth to the maximum water depth. Table 1 contains data on this question. The average for all of these reservoirs gives a mean depth equal to one-third of the maximum depth at the dam. In the later computations of areas of land that would be submerged by reservoirs a mean depth of 40 ft. is assumed, corresponding to a maximum depth of 120 ft. at the dam.

Table 2 gives average volume in earth dams per acre-foot of storage in reservoir. Quantities for earth dams were tabulated rather than for masonry or concrete in order to make the yardages directly comparable with the earth embankment in other systems of flood control. Of course, the volume of an earth dam is many times greater than a volume for a masonry dam for the same height and length. Objection might be made that earth dams require slope paving, and appurtenances, such as waste weirs, regulating gates, etc., which greatly increase their cost, to which the writer will answer that levees, to be as effective as these dams, also require a facing of concrete and frequently a cutoff of sheet piling and that the cost of revetment to prevent caving river banks is probably greater than the levee construction itself. These questions will be more fully treated in a subsequent paper on comparative costs of flood control.

Land is another item involved in all of the systems for flood control, and an argument frequently advanced against storage reservoirs is that too much land would be submerged and rendered useless for farming or other purposes.

SACRAMENTO BASIN

THE By-Pass system of the Sacramento Valley was referred to in the previous article (Engineering Record, April 4, 1914, page 391). The area of land included between the embankments of this By-Pass system is approximately 165,000 acres. The report of the California Débris Commission (House Document 81, Sixty-second Congress, First Session) contains the following construction quantities, in addition to existing levees: Embankment, 107,656,500 cu. yd.; excavation, 153,061,300 cu. yd.; subtotal, 260,717,800 cu. yd.

This report states that up to July 1, 1909, there were 520 miles of levees in forty-one of forty-eight reclamation projects in the valley. This does not include the levees of Sacramento City, nor the vast amount of work done since 1909. These levees were assumed to have an average height of 10 ft., and the volume in the 520 miles was computed to be 40,560,000 cu. yd., which, included with the new work involved in the commission's estimate, makes a grand total of 301,277,800 cu. yd.

The floods of March, 1907, and of January and February, 1909, were record ones for the Sacramento Valley. The maximum discharge for those floods was between 500,000 and 600,000 sec.-ft. The runoff during the flood of 1907 in excess of a channel capacity of 100,000 sec.-ft. was 3,500,000 acre-ft., and 6,500,000 acre-ft. during the flood of 1909. In view of the foregoing, it seems conservative to use about one and a half times this quantity, or 9,750,000 acre-ft., as the maximum storage requirements for the Sacramento basin for combined irrigation, flood prevention and power development. (The comparative storage capacities required for flood control alone and flood control combined with other uses are treated in a later paper of this series.)

TABLE 1—RATIO OF MEAN TO MAXIMUM DEPTH OF RESERVOIRS IN THE UNITED STATES

Location	Number of reservoirs included	Reservoir capacity, acre-feet	Average capacity per reservoir	Ratio of mean depth to maximum
Reclamation Service projects.....	56	12,423,695	222,000	0.283
Northern California	21	5,720,015	272,500	0.43
Southern California and Arizona.....	29	2,348,216	81,000	0.365
Allegheny and Monongahela	44	1,868,000	42,500	0.385
Totals	150	22,359,926	149,000	0.33

A storage of 9,750,000 acre-ft. at 40-ft. average depth requires an area of 243,750 acres for reservoirs. The aggregate volume in the dams at 5.41 cu. yd. per acre-foot (see Table 2) is 52,750,000 cu. yd.

The volume of earthwork for the completed levees of the lower Mississippi River has been estimated by the Mississippi River Commission as 443,000,000 cu. yd., embracing about 1500 miles of levees from Cairo to the Gulf. This estimate does not include levees for any of the tributaries of the Mississippi nor for the upper Mississippi. The total length of navigable streams, including the tributaries and the upper Mississippi, is approximately 13,000 miles. Deducting the length of the lower Mississippi, 1100 miles, leaves the mileage of navigable

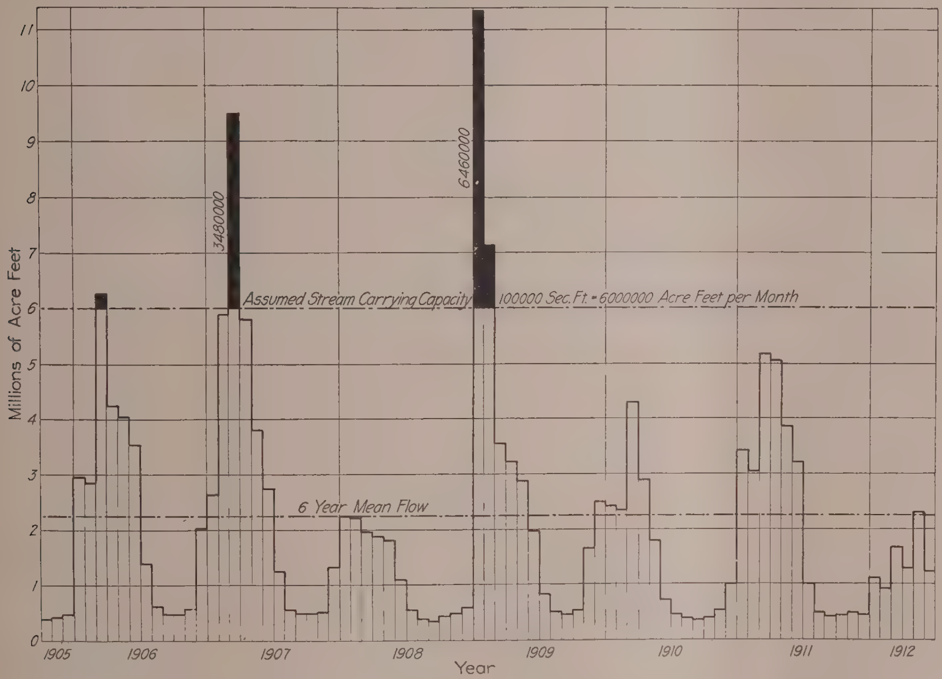
TABLE 2—EARTH DAMS FOR RESERVOIRS

Location	Number of reservoirs included	Reservoir capacity acre-feet	Volume of dams	
			Total in cu. yd.	Cu. yd. per acre-foot of storage
Reclamation Service projects.....	59	12,471,595	38,337,030	3.07
New York, New Jersey and Massachusetts	10	2,446,650	21,696,000	8.86
California	53	4,102,270	22,628,620	5.50
U. S. surveys in Utah and Colorado	22	645,485	11,743,740	18.2
Allegheny and Monongahela	44	1,868,000	21,923,000	11.75
Totals	188	21,534,000	116,328,390	5.41

Note: Table includes many reservoirs proposed but not yet built. Approximately half of the above yardage was computed by the writer from knowledge of height of dam and length of crest. Where width of valley at stream level was lacking the slopes of the hills were assumed at 1:1. Cross-section of dam, uniformly, 20 ft. wide at crown with side slopes of 1:2 and 1:3 were computed by writer.

TABLE 3—SUMMARY OF TWO SYSTEMS OF CONTROL FOR SACRAMENTO BASIN

Items	By-Pass system	Reservoir system
Area of land required, acres	166,000	243,750
Cubic yards of earthwork..	301,277,800	52,750,000



Discharge of Sacramento River and Storage Needed for 1907 and 1909 Floods

rivers not considered in the estimate of the Mississippi River Commission 11,900.

The writer has assumed levees for 2000 miles of river, or about one-sixth of the 11,900 miles of navigable streams, and an average cross-section equal to one-half the levee section on the trunk stream. The resulting yardage is equal to that of the lower Mississippi. The volume of the cross and back levees of reclamation districts and cities is estimated at 25 per cent of the river levees, or the total yardage in a levee system for the entire Mississippi basin is approximately as follows:

	Cu. yd.
Lower Mississippi, as estimated by the Mississippi River Commission......	443,000,000
Principal tributaries	443,000,000
Cross and back levees.................	221,500,000
Total	1,107,500,000

The natural flood plain or major bed of the lower Mississippi embraces a region 800 miles long and 40 miles wide, with an area of approximately 29,000 sq. miles. It has been estimated that 25,000 sq. miles of this former flood plain have been protected by the levees, leaving about 4000 sq. miles for the domain of the river in flood. If regulated to a maximum flow of 1,000,000 sec.-ft., the river would not require a greater average width than 1 mile, as the average width between banks is not greater than 4000 ft., and the total area then required for a river whose maximum flow is kept down to 1,000,000 sec.-ft. by reservoirs equals 1200 sq. miles; 4000 minus 1200 equals 2800 sq. miles, or 1,792,000 acres of land between river banks and levees. Add an average of 1/5 mile width for the 12,000 miles of navigable tributaries, equivalent to an area of 2400 sq. miles, or 1,536,000 acres, and the total area periodically submerged or rendered of little worth equals 3,328,000 acres. [This statement as to "little worth" is open to question. Very likely much of this land could be farmed, though habitations would not be permissible.—EDITOR.]

OUTLETS

THE maximum discharge of the Mississippi is 2,300,000 sec.-ft.; discharge at bankful stage, 1,000,000 sec.-ft. The excess of flood flow over channel capacity is 1,300,000 sec.-ft. With an average velocity of 5 ft. per second and a maximum depth of 15 ft. the width required to handle the excess flood flow equals 17,300 ft. Add for space occupied by levees on either side and the total width required for an auxiliary channel is about 17,600 ft. The length of the outlet from Cairo to the Gulf is taken at 800 miles. The total area required for right-of-way equals 1,710,000 acres. The volume for two lines of levees 20 ft. in height and with 10-ft. crown and 1:3 slopes equals 438,000,000 cu. yd.

Many people advocate widening and deepening river channels to increase their capacity. The work involved in such a procedure is many fold greater than by any other system proposed. To increase the capacity of the lower Mississippi 1,300,000 sec.-ft. by this method would require the excavation of 55,900,000,000 cu. yd. of material, or enough yardage to make earth dams for more than 10,700,000,000 acre-ft. of reservoir storage—a storage capacity sufficient to impound all the water from all over the earth which flows to the sea in four months. (John Murray, in the "Scottish Geographical Magazine," Vol. 3, page 76, 1887, has computed the total volume of water flowing to the sea in one year at about 6524 cu. miles.)

RESERVOIRS

IT has been estimated by army engineers that a storage of 67,200,000 acre-ft. (see Table 5 for estimates of dam yardage) would have been required to keep the discharge of the lower Mississippi below 1,000,000 sec.-ft. during the flood of 1912. To be conservative, the writer has increased this estimate to 100,000,000 acre-ft. as the maximum storage requirements for the entire Mississippi system, including a drainage basin whose area is more than one-third of the whole United States. With an average depth of 40 ft. the land submerged would be 2,500,000 acres. The volume of embankment and earth dams equals 5.41 times 100,000,000, or 541,000,000 cu. yd.

TABLE 4—SUMMARY OF DIFFERENT SYSTEMS OF CONTROL FOR MISSISSIPPI BASIN

	Outlets	Reservoirs	Levees
Area of land required, acres ...	1,940,000*	2,500,000	3,328,000
Cubic yards of embankment	438,000,000*	541,000,000	1,100,000,000
Deepening and enlarging of river channel..	....	....	55,900,000,000†

*Length considered, 800 miles. †Cairo to the Gulf.

CONCLUSIONS

IF it be borne in mind that two-thirds of the cost of reservoir storage should be charged to other interests benefited, as navigation, power development, and irrigation, leaving about one-third of the cost chargeable to flood prevention, it will be seen that flood control by the reservoir system involves less land and less yardage of embankment than any other method for protection (see Tables 3 and 4).

Flood control, by whatever method achieved, involves stupendous construction quantities. Those engineers who say in a pompous manner that the control of floods by storage reservoirs is an undertaking too vast for human effort should wake up and do a little real thinking. They will find that the storage capacity between the river levees, if all the tributaries be included, is fully equal to, if not greater than, the storage required in reservoirs. In other words, while condemning reservoirs as impossible because of the vast storage required, they create a storage just as vast but far less effective because of its shape—great length and comparatively narrow width—ineffective, too, because the water cannot be actually stored but travels as a wave. The top of the wave rides along the great channel created for it. Then, the arrogant ones should consider the results achieved by methods of impounding runoff as contrasted with methods which protect land only. On the basis of comparing the benefits derived the reservoir system could fairly involve quantities and costs three times as great as any system which wastes the water.

TABLE 5—ESTIMATED YARDAGE UNDER DIFFERENT CONDITIONS OF DAM CREATING RESERVOIR AT CAIRO ASSUMED BY COLONEL TOWNSEND

Capacity, acre-ft.	Water depth, ft.	Area of water surface, acres	Length of dam, miles	Cubic yards in dam		Height, ft.
				Total	Per acre-ft. storage	
67,200,000	15	4,480,000	334.4	91,400,000	1.36	20
67,200,000	30	2,240,000	236.0	215,500,000	3.21	37
67,200,000	45	1,493,333	193.6	371,500,000	5.53	54
67,200,000	60	1,120,000	167.0	525,000,000	7.81	70

Theoretical reservoir of 67,200,000 acre-feet, assumed by Col. C. McD. Townsend, Corps of Engineers, U. S. A., in address, "Flood Control of the Mississippi River," delivered before the National Drainage Congress, St. Louis, April 11, 1913. His assumed reservoir was entirely in excavation, however.

HARBOR WORK to cost $5,500,000 under way at Nantes, France, is divided as follows, states a consular report: Tidal basin, $772,000; bridges, $1,254,000; dredging, $965,000; quays, $1,540,000, and drydock, $868,500.

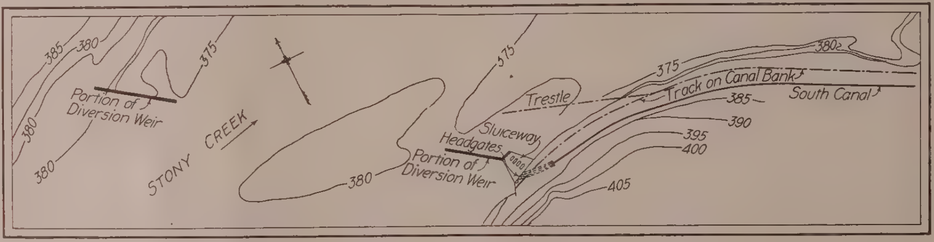
Trestle for Excavator from Canal Bank to Creek Bed

Maintenance Excavator at Orland Reclamation Project in California

Channels to Head Gates and Gravel-Filled Canals Are Cleaned Each Year by a Permanently Installed Traveling Machine

A TRAVELING excavator has been installed to keep clean and serviceable the canals at the south diversion of the Orland reclamation project in California. Water for the project is stored in East Park reservoir, the dam and appurtenant structures of which were described in the Engineering Record of June 24, 1911, page 701. The water is discharged into Stony Creek, and at Miller Buttes, 9 miles northwest of Orland, it is diverted into the south main canal. The plan shows the general conditions. There are two low diversion weirs, with an intermediate gap of about 600 ft. The creek bed consists of a large gravel bar, over which the stream is continually shifting during the winter floods. Every spring a large quantity of sand and gravel has to be removed. Originally this was done with teams and Fresno scrapers operating in the water. The water is very cold, however, and the work could not be accomplished with dispatch; hence there was delay in delivery of water to the land, with consequent injury and loss to growing crops. It was therefore decided to use some type of traveling excavator.

Although a number of different types of machines were considered, the final selection was that of an A-frame derrick with a 30-ft. boom, a double-drum hoist and two swinging drums, together with a ½-yd. clamshell bucket, all mounted on a foundation frame movable either on trucks or on skids. Power is furnished by a 12-hp Samson gas engine of 320 r.p.m., which gives an approximate hoisting speed of 75 ft. per minute. The machinery for the excavator was purchased from the Stockton Iron Works.



Plan of Diversion Works, Giving Location of Excavator Trestle

Cleaning Canal below Head Gates

For maintaining the upper portion of the south canal it was proposed to operate the excavator on trucks traveling on a track with a gage of 7 ft. 3 in. For opening the diverting channel in the creek bed to the head gates the trucks were to be discarded and the machine moved on skids, as there was considerable doubt as to the feasibility of maintaining a track across the creek on account of floods and the decay of timbers. Furthermore, with the machine on skids it became possible to reach certain portions of the sluiceway and the channel above the head gates inaccessible to a machine operating from a track without the use of a switchback or turntable, alternatives prohibitory in cost and of questionable maintenance against floods. Consequently a trestle of sufficient length to afford an easy operating grade for running the machine to and from the creek was located, together with the desired length of level grade at the end, on which the changes in trucks could be made.

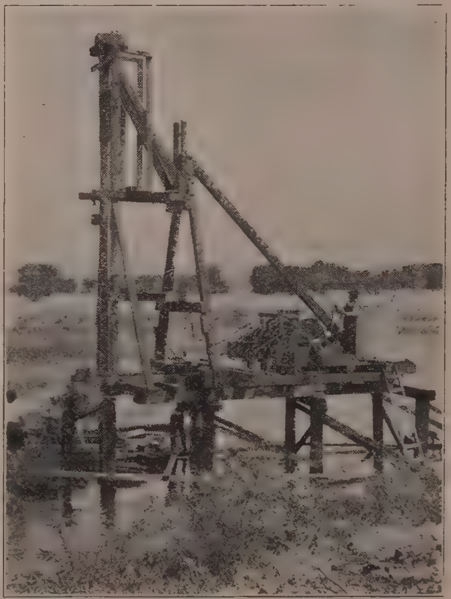
Generally speaking, the alignment of this track parallels the canal center line and is located as closely as possible to the edge of the bank. The roadbed is 12 ft. in width, with 1 on 1½ slopes. The track is laid on 4 in. of gravel ballast with cross-ties 10 ft. long laid 2 ft. on centers, and 6x6-in. wooden rails 16 ft. long. The rails are fastened to the ties by 10½-in. spikes made from ½-in. round reinforcing steel. To distribute the weight of the machine uniformly and to prevent indenting the wooden rail by the truck wheels 2x⅜-in. strap irons, 16 ft. long, were placed at the gage line on top of the rails and secured thereto with 40d spikes with countersunk heads. The rails are laid with broken joints.

TABLE 1—COST OF EXCAVATING MACHINERY

Machinery:		
Double drum hoist	$750	
Mounted A-frame derrick and boom	525	
Clamshell bucket (½ cu. yd.)	480	
Samson gas engine (12 hp)	405	
Total cost of machinery		$2,160.00
Superintendence of installation	$16.00	
Labor installing	100.43	
Preparatory labor and supplies (including freight)	50.00	
Hauling machinery	21.40	
Total cost of labor		$187.83
Total labor and material cost		$2,347.83
Proportion of general expense		273.27
Engineering and design		24.83
Total cost		$2,645.93

A trestle on a 5-per cent grade was constructed for carrying the machine from the track in the canal bank to the creek bed. Provision is made for the removal of the rails from four bents of the trestle in order that flood water may have a less obstructed flow by the trestle. Eight bents of the trestle are in the water, and as the piles are ordinary Oregon pine and subject to decay at the water line it is planned to incase the lower portions with a 4-in. shell of concrete upon the first indication of decay.

The piles were driven by utilizing the excavator itself. The boom, bullwheel and trucks of the machine were removed, a pair of skids was attached to the frame and the



Excavator Used as Pile Driver

pile driver leads were placed in position in front of the A-frame.

In the accompanying tables appear detailed costs of the excavating plant. The wages paid per day were: Foreman, $5; team, $4.75; hoisting engineer, $3.50; blacksmith, $3.20; carpenter, $3; laborers, $2.60.

TABLE 2—COST OF PILING IN PLACE

Classification:	Total cost.	Cost per lin. ft.
Superintendence	$95.00	$0.160
Preparatory labor	24.00	.047
Equipment depreciation	10.00	.017
Miscellaneous supplies	9.50	.016
Labor:		
Erecting pile driver	56.30	.094
Miscellaneous	12.50	.021
Blacksmith shop	54.40	.092
Hauling material	40.75	.068
Driving piles	108.65	.183
Framing piles	21.00	.035
Material for piling	62.10	.105
Material for pile driver	11.86	.020
Corral charges	26.00	.044
Total labor and material cost	$532.06	$0.902
Proportion of general expense	80.00	.135
Engineering	37.00	.063
Total cost	$649.06	$1.100

TABLE 3—COST OF TIMBER TRESTLE

Classification:	Total. cost.	Cost per lin. ft.
Superintendence	$142.00	$0.657
Preparatory labor	17.50	.081
Equipment depreciation	8.00	.037
Miscellaneous supplies	27.56	.127
Labor:		
Erecting pile driver	56.30	.261
Miscellaneous	20.53	.095
Blacksmith shop	89.00	.412
Hauling material	77.73	.360
Driving piles	108.65	.503
Framing piles and trestle	63.15	.292
Material for trestle	222.79	1.033
Material for pile driver	19.27	.089
Corral charges	38.00	.176
Total labor and material cost.	$890.50	$4.123
Proportion of general expense	123.83	.573
Engineering	58.00	.269
Total cost	$1,072.33	$4.965

TABLE 4—FINAL COST REPORT

Classification:	Amount.
Superintendence	$224.30
Preparatory labor and supplies	144.52
Equipment depreciation	16.00
Design	20.83
Miscellaneous supplies	90.93
Labor:	
Excavation	58.39
Building track	171.87
Installing machinery	100.43
Erecting pile driver	56.30
Miscellaneous	44.95
Blacksmith shop	120.20
Hauling material	224.51
Driving piles	108.65
Framing piles	63.15
Lumber for shelter house	14.10
Material for trestle	661.94
Material for pile driver	19.27
Miscellaneous material	10.63
Excavating plant	1,755.00
Corrugated iron for shelter house	58.74
Corral charges	69.32
Total labor and material cost	$4,034.03
Proportion of general expense	785.16
Engineering	96.80
Total cost of plant	$4,915.99

The Orland project is located in the Pacific District of the U. S. Reclamation Service. E. G. Hopson is supervising engineer of this district and A. N. Burch is manager of the Orland project, under whose general supervision this work was done. R. C. E. Weber was engineer in charge of field operations.

FAILURE TO DELIVER is charged against the Government of Western Australia, which bid for and was awarded the contract for about 75 per cent of the ties for the 1800-mile Australian Transcontinental Railway. As the Yarra and Karri forests of the State are considered practically inexhaustible, the situation is attributed to shortage of labor, the blame for which is in turn placed at the door of the Labor Party and its hesitating policy with regard to immigration. Cast-iron ties have been largely used in India, and their use in Australia has been suggested unless labor conditions improve.

Book Reviews

"The Testing of Barometers" is the title of a 12-page preliminary circular (No. 46) issued by the U. S. Bureau of Standards. The contents include a brief discussion of the uses of barometers—mercurial or aneroid—a description of the tests, instructions to those wishing tests made, and a schedule of fees. (Washington, D. C., Department of Agriculture.)

CLEAR WATER AND HOW TO GET IT. By Allen Hazen. Second Edition. Cloth, 5½ x 7¾ in.; 196 pages; 18 illustrations. New York, John Wiley & Sons, Inc. $1.50 net.

(Reviewed by G. A. Johnson, Consulting Engineer, New York City.)

This little book is small only in size. From the pen of so thoroughly informed an author as Mr. Hazen it is replete with information of value to the technical as well as the non-technical reader. Naturally enough, its chief field of usefulness will be found in the hands of those city officials who, though lacking the specific knowledge required in such cases, often are expected by their people intelligently to pass on the question of a clean-water supply.

The book covers ways and means of securing a good water supply, and also deals briefly with matters of general policy, pressure, fire service, sale of water and financial management of waterworks. New chapters have been added on the so-called red-water troubles and on water sterilization, and all statistical data have been brought up to 1910.

All in all the book is a very valuable document, and this second edition is even better than the first, which is saying a good deal.

THE CONTROL OF WATER. By Philip A. Morely Parker, A.M.I.C.E., Assoc. M. Am. Soc. C. E., M.D.I.V., B.A. (Cantab) and B.C.E. (Melbourne). Cloth, 6 x 9 in.; 1055 pages; 273 text figures and 12 diagrams. New York, D. Van Nostrand Company, $5 net.

This volume covers almost the entire field of hydraulic engineering and is written in a style suggesting both textbook and handbook. The author has carefully avoided theoretical speculations of doubtful practical value. The book, therefore, contains only derivations leading to formulæ directly applicable to designs.

In Chapter 1 are presented briefly preliminary data of hydraulics and how empirical formulæ or formulæ with experimental coefficients can be converted from the English into the metric system, and vice versa. The following chapter deals with the general theory of hydraulics and gives the fundamental equations used in hydraulic calculations. Chapter 3 deals with gaging of streams and rivers and the measurement of large bodies of water. Two subdivisions of this chapter are noteworthy—chemical gaging and measurements by traveling screen. The apparatus needed for the latter method are not shown and only the plane screen suspended from a carriage is mentioned, in spite of the advantages of screens curved like a Tainter gate and supported on floating barrels. Chapter 4 considers gaging by weirs and Chapter 5 discharge of orifices.

Collection of water and flood discharge are the subjects of Chapter 6, which is divided into two parts, the second part dealing with floods. In this section are taken up the rainfall and runoff, the influence of the climate, ground storage, evaporation, springs, storage in reservoirs, waste weirs and their capacities. Dams are dealt with in Chapter 7.

Pipes are the subject of Chapter 8; this chapter is much too brief. In America, where 18-ft. steel and 13.5-ft. wood-stave pipes are in use and large pipes are designed to operate under heads less than six times the diameter of the pipe, the formulæ given in this book are inadequate. The deformation stresses encountered in filling such pipes and the stresses due to supporting pipes on saddles have not even been mentioned. The calculation of stresses due to the fill around buried pipes is also neglected, although mention is made that such stresses might take place.

The subject of Chapter 9 is open channels and the formulæ offered are those of Kutter, Bazin and Manning. The treatment of backwater from dams, etc., is very interesting and the formulæ are simpler than those generally found in German textbooks. It seems to the reviewer, however, that the best method is not to use any other formulæ than $c = v/\sqrt{r\,s}$, and the Kutter formula for c. If the slope between the sections is assumed these formulæ will give different values of c; repeating the calculation with an adjusted value for the slope, a new set of c's is obtained. This cut-and-dry method can be applied until both equations give the same value. When two sets of c's have been obtained a fairly correct value of s can be determined graphically.

Filtration and purification of water are dealt with in Chapter 10, problems connected with town water supply in Chapter 11 and irrigation in Chapter 12. The latter refers mostly to the practice in East India, and it is not without interest to compare the structures with those in use in the Western part of the United States. Chapter 13 deals with movable dams and is very brief, mentioning only flashboards, shutters, trestles with needles or sluice gates and bear traps. Other types of movable dams can be said to be outside of the scope of the book, as they alone could easily fill a volume.

Hydraulic machinery other than turbines is described in Chapter 14, which is subdivided into seven parts: Influence of valves and enlargements, water hammer, ejectors and siphons, air-lift and hydraulic compressors, hydraulic rams, resistance to motion of solid bodies in water and impact of water on moving bodies. Chapter 15 deals with turbines and centrifugal pumps and embraces waterwheel governors and surge tanks. R. D. Johnson's paper on surge tanks, presented before the American Society of Mechanical Engineers, and the discussions by Harza, Larner and Johnson have been reprinted in abstract. The differential surge tank is also described and working formulæ are given.

Concrete, ironwork and allied hydraulic construction is the subject of Chapter 16. Concrete aggregates, the construction of forms, grouting with cement and impermeable concrete and mortar occupy the first half of the chapter and Stony gates and steel water tanks the last half. The last part of the book consists of tables of various coefficients, relating to flow of water and diagrams for discharge of water over sharp-edged and generalized weirs and through orifices, and for the velocity of water in channels having a coefficient γ in Bazin's formula of 0.109, 0.29, 0.55, 0.833, 1.54, 2.35 and 3.17. An excellent index ends the book.

The work is printed in England and the

publisher deserves praise for his thoughtfulness in using thin paper, thus enabling the binding of 1055 pages into one volume only 1½ in. thick. There are no photographs, all illustrations being line drawings, in which the workmanship and lettering are not up to American standards. Judged as a whole the book is to be commended and deserves a place in every technical library.

Bau, Unterhaltung und Verteigigung der Flussdeiche. By Geheimer Baurat Ehlers, Professor at the Danzig University of Technology. Paper, 6¾ x 9¾ in.; 54 pages; 54 illustrations. Berlin, Wilhelm Ernst & Sohn. 3.20 Marks.

The appearance of this little book on the construction, maintenance and protection of levees is very timely. The floods of last year were destructive and a repetition of the calamities will be prevented as far as possible. The author has had considerable experience in levee work on some of the rivers in Germany, the Ill, Weichsel and Oder. After a brief introduction dealing with the various purposes and types of levees, their location and height are discussed. This naturally depends on the high-water stage of the river before its regulation, on its slope and other characteristics. In this connection the author states that the coefficient *c*, which must be guessed at, makes the calculation unreliable. It would, therefore, have been of value if the coefficient *c* before and after the regulation of some notable rivers had been given. This would have served as a guide for designers in choosing a suitable and probable coefficient.

Subdivisions follow which deal with cross-sectional shape of levees, influence of character of available materials, etc. The shape advocated by the author is somewhat different from that usually found here. The levee most used in this country is of a trapezoidal section, but as any embankment holding water back is weakest at its downstream toe, the author recommends an addition at this point. The feature is well shown in a figure indicating the probable saturation due to penetration and that due to capillarity. The slopes recommended are 1 on 3 on the upstream and 1 on 2 on the downstream side, provided the extra thickness at the toe is added.

Construction of levees is treated in a brief but meaty chapter, and there follows a warning against building levees so that the upper part offers less resistance to penetration than the lower. The washout of the Jonasdorfer levee in 1888 is given as an example of this faulty design. Allowances to be made for settlement and shrinkage after the construction of the levee, protection of the upstream slopes and reinforcing of old levees are briefly mentioned.

A chapter of interest is the one entitled "Summer Levees"—levees that are high enough to hold back ordinary summer freshets but not spring floods. As the water cannot be allowed to overtop the levee, spillways must be provided at certain intervals. Openings and culverts through levees are then described, and following this is a chapter of drainage ditches inside the levees. Drainage projects and organizations for inspecting levees are then briefly dwelt upon. The protection of levees in emergencies is the subject of the next chapter. Organization of the force and the character of the work necessary temporarily to protect and reinforce levees are discussed. The last chapter deals with repair of washouts. An appendix contains abstracts of the Prussian Water Law of April 7, 1913.

Suspension Bridges, Arch Ribs and Cantilevers. By William H. Burr, Professor of Civil Engineering, Columbia University. Cloth, 9¼ x 6 in.; 417 pages. New York, John Wiley & Sons, Inc. $4.50 net.

(Reviewed by Frank H. Constant, Professor of Structural Engineering, University of Minnesota.)

Engineers will note with interest the advent of another work in the field of higher stresses. About two-thirds of the volume is upon suspension bridges.

Chapter 1 gives the approximate theory of the stiffened suspension bridge with parabolic cable, based upon the assumption that the stiffening truss carries no load as an ordinary truss, but must act wholly in connection with the cable to produce a uniformly distributed downward load upon the latter through the instrumentality of the hangers. This assumption is by no means true and the error will vary greatly according to the depth and stiffness of the truss. In this chapter the ends of the truss are considered, first anchored and then free, and the positions for either a continuous load or a single weight and the corresponding values of maximum moments and shears are derived for every part of truss or cable.

Chapter 2 is a continuation of the same treatment for the three-hinged stiffening truss. The author considers this solution statically determinate, which is only true for the assumptions noted above. But since the relative variations in deflections between cable and truss are now confined to half spans, instead of the entire span, they must become much lessened, and the approximate method, as here set forth, must lead to more accurate results than when the truss is unhinged.

In Chapter 3 the statically indeterminate nature of the problem is recognized. This chapter has to do wholly with the general mathematical properties of the cable, considered without reference to the stiffening truss.

Chapter 4 contains 126 pages and is called "Statically Indeterminate Stiffening Trusses." There is, except rather incidentally in a single paragraph in the heart of the chapter, no clear-cut statement of what the methods of attack are to be. This chapter develops the method of least work. The preliminary assumption is made that the cable remains parabolic under stress and that therefore the stiffening truss acts as a uniform distributor of such live load as reaches the cables. The trusses also carry some of the moving load to the piers as simple or continuous spans. The dead load is all taken by the cable by a preliminary adjustment at mean temperature during erection. The general expressions for moments and shears for simple and continuous trusses and the horizontal pull in cable are first obtained, and the solution is based upon the condition that the total internal work produced by the elastic deformations and the stresses must be the least possible. There is a lengthy mathematical treatment of influence lines for the several classes of trusses, followed by a numerical application to the Manhattan Bridge. The three rather meager plates are inadequate for so graphical and important a subject.

Chapter 5 bases the theory of the stiffening truss upon the method of deflections. The same assumption as to the cable is made as in Chapter 4. The work performed by the dead load and the part of the moving load thus carried by the cable, acting through their respective displacements, is equated with that expended in stretching the suspenders and cable, giving the fundamental expression from which the cable stress is determined. The formidable equation 58 on page 237 results. The author discusses the terms depending directly upon kind of loading, but the treatment is incomplete in not showing conditions of loading giving maximum moments and shears. The case of stiffening truss in center span only is considered, and application is made to the Manhattan Bridge, using, however, a single 10,000-lb. load at the quarter and center of the span. The author concludes that the least-work method differs from the deflection method by from 4 to 8 per cent for the two cases considered.

In chapter 6 thermal stresses are considered for the first time.

Chapter 7 contains the graphical treatment of the arch rib by the method given in the author's former work, based upon the trial equilibrium polygon process. In the opinion of the reviewer the method based upon the crown stresses, and employing analytic and tabular processes, as given in some of the later treatises on this subject, is more expeditious and accurate. The fundamental equations here used are given only by reference to the author's earlier book. Fixed-ended and hinge-ended ribs are considered. Thermal and rib shortening effects are also included. An application is made to a 151-ft. span, the data for which appear in the next chapter.

In Chapter 8 the author develops an analytic method of solving the problem of the fixed-ended arch by the law of least work, including not only bending effects but direct thrust and shear as well. Reference is again made to his other book for his fundamental equation 7 on page 327. The term for the work of the shear is twice too large, which error runs throughout the following equations. Application is made to the 151-ft. concrete arch treated in the previous chapter by the more usual analysis. It would have been a matter of interest had the author compared the results by the two methods and clearly shown the exact effect, in stress percentage, of including the shear in the arch analysis.

Chapter 9 contains a short graphical and analytical treatment of the three-hinged arch for both vertical and inclined loads. Chapter 10 gives a short analysis of the spandrel arch of two hinges, which, however, fails to include the important effect of thermal changes.

Chapter 11 gives the analytical treatment of cantilever structures for wheel loads and moving uniform load, and the action of the wind; also an analytical discussion of the economic lengths of spans, arms and width between trusses. Article 3 develops the formulæ for the cantilever without a suspended span, with extension of the theory to cover the case of Queensboro Bridge. There are, however, no numerical examples.

Appendix 1 gives the conclusions of Professor Steinman in his book, "Suspension Bridges and Cantilevers," and in two papers presented before the Congress of Engineering and Scientific Societies at Spokane in 1913, regarding the greatest span limit, greatest practical span and greatest economical span of either the suspension or cantilever type.

Appendix 2 reproduces from the author's "Elasticity and Strength of Materials" the analysis for formulæ for rectangular reinforced-concrete beams, based upon linear variation of compressive stress across the section of the beam.

The book is almost wholly mathematical in character. It is generally deficient in a clear-cut exposition of the process about to be or being pursued. The derivations frequently do not follow in logical sequence and often contain steps which are not mentioned or are circuitous and exceedingly difficult to follow. The exact theory of the suspension bridge must of necessity involve long and tedious mathematical processes. This is all the stronger reason why all of the substitutions and steps should be clearly set forth and be read with ease. The book is also open to criticism in the meagerness of its illustrations and practical examples. A computer would have difficulty in finding a complete statement of notation, which often changes in the various articles.

The author states that the book was written to meet his needs in the classroom. It will hardly find any general application in undergraduate work owing to its complex mathematical character and the infrequent occurrence of the suspension problem in practice. It will be of value to all engineers interested in the higher analysis of bridge structures and those whose practice bring them up against the problem of the suspension bridge.

Letters to the Editor

To Find the Point of Intersection of Two Grades

SIR: Referring to your comment on Mr. Yoakem's method of finding the point of intersection of two grades in the Engineering Record of Feb. 14, 1914, page 203, in which you called attention to the fact that the formulæ would not hold good in the case of two grades of the same sign, please allow me to add the following, which covers this situation. Using the same notation as Mr. Yoakem, and referring to Fig. 3, which supplements his Figs. 1 and 2, we have two cases—(1) when both grades are descending and (2) when both are ascending.

Case 1.—The equation of the line AB of

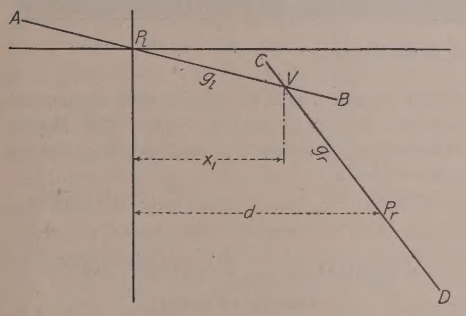


Fig. 3—To Supplement Figs. 1 and 2 in Issue of Feb. 14, 1914, Page 203

g_l grade referred to axes through P_l is

$$y = -(g_l/100)\,x \qquad (6)$$

and the equation of the line CD of g_r grade through the point P_r is

$$y = -(g_r/100)\,x + b \qquad (7)$$

where $b = g_r d/100 -$ difference of elevation e between P_l and P_r. Therefore

$$y = (g_r d - g_r x)/100 - e \qquad (8)$$

Equating the values of y in equations (6) and (8), and solving for x_1, we have for the abscissa of the point of intersection

$$x_1 = (g_r d - 100\,e)/(g_r - g_l) \qquad (9)$$

where d and e are expressed in feet, g_l and g_r in feet per 100 ft.—all positive values.

Case 2.—By inverting Fig. 3 we have a figure covering Case 2, and as the distance x_1 is the same as in Case 1 it will be found that equation (9) holds good for this case, and therefore holds good for all cases where the grades are of the same sign.

The great advantage in using the above formula lies in the fact that all signs may be disregarded in substituting values.

Eugene, Ore. H. C. REEDER.

Establishing Timber Standards

SIR: The recent discussions which have been printed in the Engineering Record regarding factory timbers will, no doubt, be instrumental in bringing about some changes in the methods of grading and marketing such timbers. It is to be hoped that this will be done, as the writer is convinced that the ordinary buyer has not always obtained the class of timber he thought he was getting. Whether this is the fault of the producer or the retail dealer is hard to say, but the fact remains that the regulations have not been what they should have been.

In the Engineering Record of May 31, 1913, the writer presented some tables and diagrams on the strength of standard-size yellow-pine timbers and in the article appurtenant thereto ventured the opinion that "most of the yellow pine on the market in the Central States is of the quick-growth variety." The latter term may have been somewhat misleading, but it was intended to cover short-leaf, bull pine and other pines which are hard to distinguish from long-leaf.

It is admitted that there is plenty of long-leaf yellow pine of excellent quality obtainable, but why should it be necessary when this timber is specified, especially for small orders, to require very rigid inspection in order to be certain the material secured is in accordance with the specifications?

It is not my intention in this letter to criticise the use of timber for building construction, as I believe that, with the required quality and in the proper place, it is on a par with any other material. It is not to be inferred, either, that the use of short-leaf and other pines of good quality is to be avoided in factory buildings; but the strength and durability of the species used must determine the sizes needed to support the loads to be carried.

In your issue of March 21, 1914, Mr. North states: "There is no assurance that a specification made by an engineer reaches the producer, and the retail dealer in many instances delivers an article conforming to his idea as to what class of timber he can get the engineer, architect or contractor to accept." This is certainly a condition which should not obtain among those interested in upholding the position that good timber deserves. What has brought about this condition? Surely the honesty and integrity of reliable dealers are not to be questioned. Wherever the blame may lie, it is evident that a remedy must be applied soon if yellow pine is not to lose favor among engineers, architects, contractors and owners. When the proper solution has been found the discussions in your magazine will have done much, in my opinion, to have brought this about.

Columbus, Ohio. J. J. MORGAN.

Contractors' Troubles

SIR: I presume that in spite of all the books and articles written on contracts and the legality, fairness, or justice of corporations in their treatment of contractors there will always be muddles that we, the common people, will never be able to understand. I read with interest your editorial in a recent number in which you side with the court that decided against reconsideration of contractors' bids merely because one of the contractors erred in his computations. I, also, agree with the court.

But I am at a loss to know just where one should stand in a case that was recently called to my attention, where two contractors bid on a certain job in the specifications of which there was a typographical error. One of the contractors, in spite of the error, bid intelligently, knowing it to be an error, without giving the matter further thought. The second contractor, not knowing conditions as well as did the intelligent bidder, interpreted the specifications exactly as they were typewritten and won the bid because the typographical error was in his favor.

Even after losing, the first contractor did not know why and did not inquire. It was not an uncommon event for him to lose a contract. But after the winner began to study conditions carefully, preparatory to the actual work, he caught the error and called it to the attention of the corporation, stating that the error would cost the corporation $500. However, as is so often the case, the corporation couldn't "see it that way" and bluntly re-opened bids, informing the "losing contractor" that if he wished he could re-bid. The erstwhile successful contractor re-bid, but this time he lost and the contractor who bid intelligently in the first place won.

The final loser did not go to court over the affair because, I suppose, court people are not always found to be congenial. I believe he was wise. Still, I harbor the notion that the corporation was a trifle unjust in not giving this man preference. Most men (but I cannot say the same for corporations) are usually willing to make reparation for errors that may have caused the party of the second part trouble or expense.

New York City. N. G. NEAR.

Lettering Boundary Lines

SIR: In answer to the letter, "Lettering Boundary Lines," appearing in the Engineering Record of March 28, 1914, it might be said that there is no general agreement as to whether courses should be lettered so as to have the bearing read in the direction in which the course is supposed to run or whether the lettering should be kept right side up on the sheet. As Mr. Shaw correctly observes, surveying textbooks do not generally take up the matter.

Both methods are followed to a very large extent, and either arrangement is justifiable. In lot subdivision work, or wherever a number of parcels are shown on the same map, it is the custom not to attempt to indicate direction by the position of the lettering along the course. This follows almost necessarily, since when some courses are common to two parcels it may be necessary to conceive the course as running one way—northeast, for instance, when following around one parcel, and the opposite way, southwest in this case, when following around the other parcel.

However, where separate parcels are surveyed, and particularly where they are parcels other than lots, the advantage of writing the courses in such manner that in reading them the eye is compelled to follow around the traverse in the order in which they have been calculated to succeed each other is very considerable.

The average conveyancer describes all parcels in much the same manner, following a stock description: "Beginning at a point —— and continuing thence —— to another point; thence —— to another point, and so forth, back to the point of beginning." This becomes so much a matter of habit that the courses and distances are selected from a survey and substituted in this form without any further thought, the conveyancer simply starting at one point and following around the traverse and transcribing whatever he finds recorded against each succeeding course. It is not uncommon that every course in the description is reversed, north appearing for south and east for west, simply because the surveyor calculated his courses to follow in order, going around the traverse in one direction, and the conveyancer happened to elect going around it in the reverse direction.

While such an error may be only amusing, it is far more annoying where only a single course is reversed in the description, and where this course happens to be a very short one, such as an offset in a fence line that does not plot up very clearly on the map, the error may not be easily detected, and the survey may have to be refigured before the ambiguity can be removed.

Accordingly lawyers will generally prefer to have the bearings written so that they can be read in only one way—that is, reading around the course, and placed upside down if need be. It may be of interest in this connection to note that the State of New York uses this method quite generally in getting out appropriation and condemnation maps. It is also of interest to note that this custom is so prevalent in New York State that the writer has seen lot subdivisions and town additions in which the subdivisions themselves were made so that all bearings would run horizontal or else be readable looking from the right side of the sheet toward the left; the outline, or original traverse, was still retained in the other form so that it would follow on around.

Brooklyn. BRUNO C. LECHLER.

SIR: Referring to the inquiry of F. H. Shaw appearing in the Engineering Record of March 28, 1914, as to the proper method of lettering boundary lines of properties, survey traverse lines, and in fact all lines constituting the survey courses referred to the meridian, the writer wishes to state to Mr. Shaw that his question seems very pertinent, especially when considering large sheets. Such survey maps are cumbersome and cannot readily be turned, nor is it practicable to remove thumb tacks or walk around the drafting table in all instances.

In large sheets like the survey of immense farms or coal-land options the writer makes use of lettering upon all courses in the upright position, in the case of courses running from right to left, as well as those from left to right. The distinguishing means are supplied in the addition of small arrowheads, pointing ahead the direction taken by the instrument man. This artifice, while perhaps not borne out by any early tradition, seems to the writer to answer every purpose of surveys of large proportions, and affords better results with its continued use.

WILLIAM P. SLIFER,
Pittsburgh. Consulting Engineer.

SIR: Replying to the inquiry of F. H. Shaw, regarding the lettering of boundary lines, I would say that in "Gillespie's Surveying," under Article 199, Field Notes, is shown a sketch giving the courses and distances written along the line in the direction in which the description is to be read. Also, in Johnson's "Theory and Practice of Surveying" under Article 175, Field Notes, is shown a sketch giving the course and distances so as to read from the bottom of the plan, regardless of following the direction in which the course runs. According to these two authorities it would seem to be proper to use either method of recording the courses and distances upon the plans. The primary object of lettering plans is to give the information in the simplest form and no error could rise from a plan in which the courses were given in the direction in which the lines run.

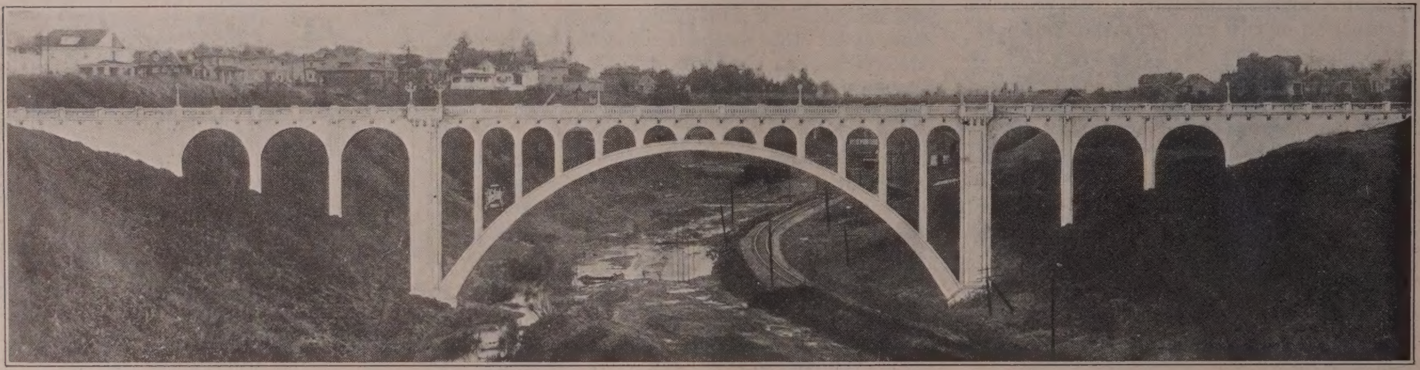
HARRISON P. WIRES.
Gloucester, Mass.

SIR: Regarding the inquiry of F. H. Shaw in your issue of Mar. 28, in reference to the proper method of writing courses on a traverse or property boundary map, I would say that there is no fixed law. Surveyors vary in their customs, but in my experience, in which the maps of hundreds of surveyors, old and new, have come under my notice, the most favored custom is to write the courses along the lines in the direction in which the description is to be read. Textbooks generally recommend that the map be drawn with the top north, the sides parallel to the meridian and the meridian designated by an arrow.

If this could always be followed there would be little choice in writing the courses. But it sometimes happens that a map may be made more compact and easy to file or handle by placing the border or margin irrespective of meridian. In such case if a draftsman omitted his meridian arrow or if by any chance a corner of the map showing the meridian arrow was torn off it would be impossible to tell where the north lay if the courses were written always to read from bottom of map irrespective of direction. Danger also arises from the fact (as I have known in several cases) of the lawyer drawing the description reversing a course, and unfortunately it is too seldom that the description drawn from the map is referred back to the surveyor.

To conclude, if the courses are written in the direction in which the description is to be read there is no chance of error or doubt of north point, and the only argument against this plan is the very slight inconvenience of turning the map as the courses are read off.

Orange, N. J. W. R. KINSEY.



Sketch of Proposed Bridge on Actual Photograph to Show Effect of Improvement

Visualizing a Proposed Civic Improvement

SIR: Herewith I call to your attention a method of indicating to the eye the appearance of a prospective bridge, as developed by H. W. Holmes, chief of the bureau of highways and bridges, city of Portland, Ore.

Mr. Holmes designed and prepared the plans for a bridge carrying Sixteenth Street over Sullivan Gulch. To present his plans to better advantage to the Common Council and taxpayers for their approval, he had a photograph taken of the bridge site, with two points on the center line of the bridge a stated distance apart, so marked as to be identified in the photograph. With these points known, the scale of the photograph was determined, and the elevation of the bridge was superimposed upon the photograph to said scale and in proper relation to the contour of the ground as determined by said datum points.

A second negative was then taken of the structure as detailed on the photograph, with the result indicated by the view shown.

Mr. Holmes has cleverly attained the desired end, and the method seems worthy of record.

The bridge shown above has not been built.

Portland, Ore. E. I. CANTINE.